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GENERAL SIR GEORGE W. A. HIGGINSON, K.C.B., in the Chair.

ELECTRIC BALLOON SIGNALLING.

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To obtain altitude as a vantage point for signalling has been for some time past the aim of the Naval and Military Engineer. It has even been suggested that the fleeting clouds might be used as a medium to reflect an intermittent beam of light projected upon them from the ground. With such a system there are obvious disadvantages. The cloud might vanish while delivering a message, in the midst of a word, the result being most disastrous mistakes and confusions. For instance, such a message as "Send troops to California" might be shortened by the caprice of the cloud to "Send troops to Cali," a town in Colombia, South America. This mistake would entail a long march across Central America. Or a Swiss order to proceed to Bernex or Bernina, two opposite extremities of the country, might become Berne—in the centre. Therefore such a method of signalling would hardly be practicable.

Rocket signalling, though useful for a preconcerted signal, cannot be said to be well adapted for conversation by sea or land. A great step in advance was made when the value of the captive balloon was recognized as a means of obtaining altitude for signalling in the field, which can be carried on from the car of a balloon by flags, lanterns, and other methods. But signalling from the car of a balloon necessitates the use of a balloon of considerable size; for it must not only be able to lift itself and the captive rope, but it must also be able to lift the car and one or more signallers, and the size of a balloon capable of doing this presupposes pretty calm weather; for though, when a balloon is well up, its size helps to steady it, yet all who have worked with captive balloons will bear out my assertion of the difficulty and sometimes impossibility of filling a large balloon in

half a gale of wind In attempting to signal in rough weather from the car of a balloon, there is, moreover, the danger to its human occupants to consider. Then the transport of an ordinary balloon equipment is no small matter, necessitating a considerable number of steel tubes of compressed hydrogen gas, or a bulky apparatus for generating the hydrogen on the spot. The difficulties in the way of the use of large balloons in the navy would be still greater, and the danger to human signallers aloft in rough weather would be much enhanced. But, notwithstanding the past difficulties that have beset aerial signalling, I think you will agree with me that no army can be said to be fully equipped that does not possess some such practical method, nor is there a navy that would not be better armed by the addition of a ready means of signalling at altitudes.

Some few years ago it occurred to me to so apply electric flash signalling to a captive balloon, that the operator and most of the apparatus may remain on the ground. In this system, since the weight of the car and operator is abolished, the balloon can be of such a size as to be portable, quickly inflated, and easily manipulated. The invention is patented in Great Britain and in several foreign countries of military importance. The apparatus is as follows:—In the interior of a balloon, which is made of a material that is translucent, and filled with pure hydrogen or coal gas, are placed several incandescent electric lamps. These are in metallic circuit with a source of electricity on the ground. In the circuit on the ground is an apparatus for making and breaking contact rapidly. By varying the duration of the flashes of light in the balloon, it is possible to signal according to the Morse or any other code. In my experiments I have used four different sizes of balloons. The largest size has a gas capacity of about 4,200 cub. ft., and diameter of 20 ft. The next size has a capacity of about 3,200 cub. ft., and diameter of 18 ft. The next a capacity of about 2,000 cub. ft., and diameter of 15 ft. The smallest a capacity of about 1,600 cub. ft., and diameter of 14 ft.

For military purposes the first size is the most satisfactory, and with pure hydrogen such a balloon will lift over 1,000 ft. of the electric cable. The smaller sizes are more suitable for navy signalling, where reduction of weight and size of balloon is of still greater importance. Lieutenant Jones, in his excellent lecture on Military Ballooning delivered in this theatre last February, mentioned that the size of the normal English observation balloon was 10,000 cub. ft. capacity. This is an admirably small capacity for an observation balloon, and it is doubtless the comparative lightness of the material out of which our own Government manufacture their balloons, that enables a balloon of this small capacity to be used for taking up two men. But even this sized balloon is of more than double the capacity of the largest sized signalling balloon that has been made. To fill the 10,000 cub. ft. balloon in the field, about eighty-four steel tubes of compressed hydrogen would be required, each of these, according to Lieutenant Jones' figures, being about 8 ft. long, $5\frac{3}{8}$ in. in diameter, weighing some 70 lbs., and containing 120 cub. ft. of hydrogen. With the largest mentioned sized signalling balloon, less than half that

TO ILLUSTRATE MR. BRUCE'S PAPER.

FIG. 1. BALLOON.

a. Ladder Lampholder.

FIG. 2.

LADDER LAMPHOLDER.

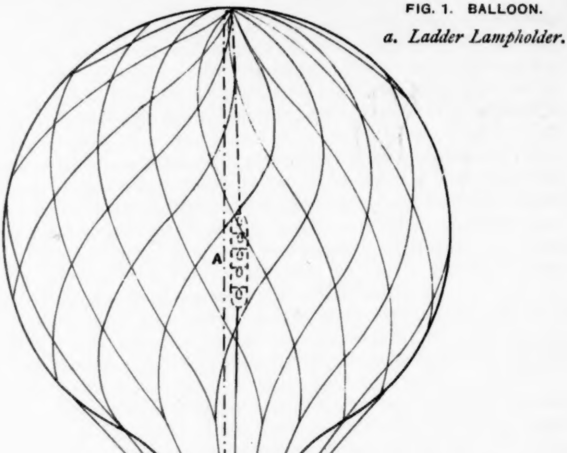

FIG. 4. SIGNALLING KEY.

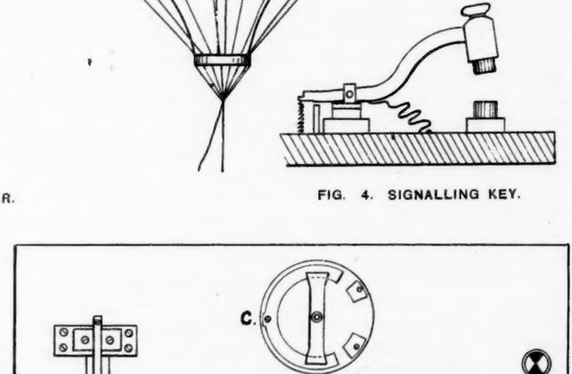

FIG. 3. SWITCHBOARD.

a. Key.
b. Ammeter.
c. Switches.
d. Safety cut out.

HARRISON & SONS. LITH. ST MARTINS LANE. W.C.

number of tubes would be required, while in the case of the smallest only about fourteen tubes. The contrast of portability appears still greater when we compare it with the larger observation balloons used on the continent; for instance, the French Government use, I believe, a balloon of some 19,000 cub. ft. capacity. This would require some 159 tubes of gas to fill it.

The most suitable material for making the signalling balloons is a thin cambric. This, when coated with a varnish of a light colour, forms an exceedingly translucent medium. It is impossible to inflate a balloon of the size required for practical use in this theatre. I must be content this afternoon with showing you a working model. This is made of exactly the same material as the larger balloons. The apparatus for making and breaking contact, however, is on the same scale as that actually used. It is in outward form somewhat like a Morse key. It is, however, in reality essentially different. An ordinary Morse key, such as is used for telegraphy, would not be able to withstand the large currents used to light the lamps. In the first key I made, which I have here, there was a rubbing contact faced with platinum. This is the form of key supplied to the British Government. This evening I am using an improved key. In this there are carbon contacts; these are easily renewed at trifling cost when worn away by sparking. The Belgian Government are using this latter form of key. The key is placed on a switch board, so that the current can be turned on to the lamps in the balloon, either through the key, or directly, for continuous illumination; each switch board is fitted with an ammeter, to show the amount of current taken by the lamps in the balloon, so that if a filament of a lamp should break, the decrease of quantity of current taken would at once be registered. Before I describe the other parts of the apparatus, I will show you the model balloon at work. I depress the key and the balloon appears like a globe of fire. By varying the duration of this globe of fire by long or short depressions of the key, it is possible to signal sentences. I will now signal a sentence.

With regard to the speed of signalling, this depends upon the thickness of the carbon filament of the lamps used in the balloons, and with the use of lamps of very thin filaments it is possible to attain considerable speed. At the present moment there is a monopoly of lamp making, and the makers have not turned their attention to the production of exceedingly fine filaments; but in a few months' time the lamp patents will expire, and then it will be possible to have an ideal lamp, fulfilling the requisite of fine filament, moderate voltage, and suitable candle power.

The arrangement for suspending the lamps inside the balloon consists of a holder made like a ladder, so that the lamps are placed one above the other in multiple arc. This arrangement I have here. Six lamps of nominally 8-candle power, but worked to a much higher candle power, give good results. The signals produced by six such lamps were seen at Uxbridge when the balloon was on exhibition in the grounds of the Albert Palace, Battersea. This is a distance of some 16 miles. By increasing the candle power, the distance the

signals can be seen is naturally increased. When I first commenced my experiments I was assured by an eminent electrical engineer that continuous flashing would so shorten the life of the incandescent lamps that the method would be almost impracticable. Experience shows that this is not the case, although the lamps in my balloons have been systematically worked to almost double their candle power. The six lamps used during a month's working in the Albert Palace Grounds in the summer of 1885, served for the Government trial at Chatham in the ensuing autumn, again in the following January for the experiments at Aldershot, and subsequently for further experiments. In fact, a filament has never yet gone while in use. This particular form of ladder holder is convenient because of the small breadth of the ladder, which is easily admitted into the neck of the balloon, which is generally only a few inches in diameter. In the valve of the balloon is a pulley block, by means of which the ladder of lamps is hauled up into the balloon, and its height adjusted after the balloon is filled with gas. I once, however, abandoned the ladder-shaped form of holder for the kind I have here. This holder was made for the gigantic electric balloon of 100,000 cub. ft. capacity, which I made for the Crystal Palace Company, and which was designed to take up passengers for captive ascents, as well as for flashing signals. This accounted for the size of this special balloon, which was anything but portable. The lamps are in this case placed at certain angles on a kind of ball to obviate any shadow of the holder being formed on the surface of the balloon. In the case of the ladder, there is a slight shadow on the balloon, but its existence is of really no importance.

The efficiency of the ladder lamp holder in doing its work was shown conclusively on the occasion of the escape of one of these balloons, when ascending in the grounds of Olympia. An assistant, instead of attaching a suitable captive rope, attached by mistake an old discarded one, which snapped in the high wind. The electric cable, being only loosely connected with the ladder holder, parted from the balloon the same moment, and the balloon sailed away to the N.W. About two hours and a half afterwards, some men on duty at the Waterworks, Battersea, heard a thud on the ice, and going out saw the balloon, which had luckily found a return current, and fallen not so very far from the place whence it started on its excursion. It was hauled about and bumped upon the ice by the men who rescued it; but, notwithstanding, when the lamp holder was examined some weeks afterwards, all the lamps were in position; the glass bulbs of three only were broken, three were left intact, and have since been used for signalling purposes.

The electric cable which connects the lamps to the source of electric power and the signalling apparatus on the ground is a very important feature, the desideratum being to combine lightness with current capacity. The cable is made of strands of copper, so as to be very flexible; both leads (each insulated) are enclosed in one water-proofed outer insulation. There is no reason why the captive rope and electric cable should not be all in one. There is, however, this

advantage in keeping the two separate. In the case of wind—the bugbear of captive balloons—the electric cable hanging loosely acts as a guy rope to steady the balloon. The first cable made weighed about 40 lbs. per 500 ft. of twin cable, that is a circuit of 1,000 ft. The improved cable made for the Belgian Government, of the same current capacity and flexibility, weighed only about 30 lbs. for the same length. I have 500 feet of this cable wound upon this reel. In some newer cables, now being prepared, still greater lightness and flexibility will be attained.

As a source of electric power for lighting the lamps I have generally used storage batteries. When a dynamo machine is available for recharging this is about the best method. Storage batteries are exceedingly reliable, even under rough treatment. When I was taking part with these balloons in the military tournament at Cork, last August, the electric storage cells were charged in London, and shipped off by steamer to Cork. When they arrived at Cork, they needed no recharging; furthermore, they travelled back in the same manner, and were found eight weeks afterwards to be nearly fully charged. The storage battery I have generally used consists of 25 cells; each cell weighs 24 lbs. The size of each cell is 4 in. long, $7\frac{1}{8}$ in. wide. Its height is $13\frac{1}{2}$ in. The whole set of 25 cells takes only a space of 3 ft. by 1 ft. 8 in. Circumstances, however, may arise when a dynamo machine would not be at hand. In such a case a Liliputian steam-engine and dynamo combined would be the best method of obtaining power, or a small gas-engine, worked by the hydrogen gas, might be used, or even if no other power could be obtained, a small dynamo can be worked efficiently by manual labour

The most convenient way of obtaining the gas for filling the balloons is to use hydrogen gas compressed in cylinders, and it is preferable to use pure hydrogen instead of carburetted hydrogen, as the former has about double the lifting power of the latter.

The British Government was, I believe, the first to use gas compressed in cylinders for filling their balloons. The system is both manageable and economical. On the occasion of the official trial of my signalling balloon at Chatham, it was filled with hydrogen that had actually been used for balloon inflation at Suakim during the Egyptian war, and rebottled. The gas did not seem to have lost much of its lifting power. To show how easily and quickly a balloon can be inflated from steel cylinders, I will fill this small balloon. Now that it is full, I will let it rise to the ceiling. In the case of these signalling balloons, it is not necessary to have any drum to wind the balloon up and down; all such apparatus adds to the bulk of appliances to be transported in the wagons. The captive rope is merely passed through a pulley block of this simple description, and then held by hand. The pulley block can be fastened to a heap of sandbags, or anything weighty. The electric cable hangs loosely. In windy weather, in addition to the main captive rope, it is advisable to use guy ropes.

When this apparatus was first brought out, it was a matter of surprise to some that the electric lamps are placed inside the balloon,

instead of outside, below the balloon. From the first I was of opinion that although the candle power is somewhat diminished by placing the lamps inside the balloon, still for ordinary conditions of weather, the best results are obtained by placing the lamps inside. Experience and the opinion of experts have since proved that such is the case. The fact that in flashing incandescent electric lamps the filament does not go out instantaneously, is apt to cause a blurring of the signals when naked lights are used, while by placing them inside the balloon, this indistinctness is obviated, as the filament itself is never seen. I have arranged an experiment to show you this. I throw upon this screen by means of this projection apparatus, the image of the white-hot filament of carbon inside an incandescent lamp. I will now connect this lamp to my signalling key, and observe when I flash the lamp, the glow does not abruptly cease after I break contact. There you see it dying away gradually. I have, however, devised an arrangement by which the lamps can be placed outside the balloon if desired. It is in form somewhat similar to the holder used inside the balloon at the Crystal Palace. The six lamps which project from the ball when suspended from the balloon, give at a height the appearance of a single light, as if it was a small arc lamp. But, as I have pointed out, the use of the lamps outside the balloon is not satisfactory. To thus place a source of light in the midst of the gas inside a balloon would not have been possible until the development of the electric light. Many persons even now seem to think the proceeding of showing a light inside a balloon a dangerous one. I have therefore arranged a few experiments to show you that the flashing of the filament of an incandescent electric lamp inside a balloon is not attended with any danger. If I take a jar of hydrogen gas in my hands, and insert a lighted taper at the mouth, the gas catches fire at the mouth, but the taper goes out when I thrust it upwards into the jar. Hydrogen gas takes fire under certain conditions, but is incapable of itself supporting combustion. The flame you have just seen burning at the mouth of the jar is the effect of the great affinity which exists between the atoms of hydrogen and the atoms of oxygen, which latter, in the atmosphere of this room, border upon the hydrogen of the jar. Further up in the jar the hydrogen atoms have no oxygen atoms wherewith to combine.

Now it may seem a surprising assertion to make, but it is nevertheless true, that one could place a red-hot poker in the body of gas in a balloon without setting fire to it. If I were to ask anyone to do so, I am sure he would decline, and say the gas would take fire as he placed the poker in the mouth. This is quite true, and to perform the experiment successfully, he would have to avoid the borderland altogether. The puzzle is, how to put a red-hot poker into the body of a gas balloon, and yet avoid the borderland. Now I will show you how to do this. Here is a glass globe through which a continuous stream of coal gas is passing. You see this must be so, for I have ignited the gas jet coming from the globe. I have stretched a little piece of platinum wire across the terminals of an electric battery, and placed these terminals inside the globe. Now I will cause the

electric current to pass through the piece of wire, and it becomes red hot, and we have this condition of things, a piece of red-hot metal unprotected inside a globe filled with gas. Now if we were to substitute a balloon for the globe, and have a battery of exceeding power, and if we were to place a poker between the terminals of the battery, the red-hot poker in a balloon would be a *fait accompli*. The incandescent lamps which we place inside the balloon consist of a thin filament of carbon enclosed in a glass globe exhausted to a high degree of air. This filament of carbon is raised to a white heat by the electric current.

In a previous experiment you have seen the image of the white-hot filament of carbon. Here I have another globe filled with gas, inside which is an incandescent lamp. This is the condition of things we have in the balloon. But, as you have seen by the experiment of the white-hot piece of platinum inside the other globe, the filament of that lamp could glow as safely were it not thus protected in a glass bulb, since it would be in an atmosphere of coal gas. Now, some persons may say, suppose by accident you get an explosive mixture of oxygen and hydrogen inside the balloon, and that this fragile little bulb breaks. Well, supposing it to break: firstly, the shock of the breakage of the glass globe would probably destroy the delicate filament of carbon, and cut off the current before any explosive consequences would take place; secondly, suppose the filament does not break with the glass globe, as might happen if the glass globe was only cracked, then it is probable that the oxygen present would immediately destroy the filament, and interrupt the current before an explosion could take place. It has been said that one might break a lighted incandescent lamp in the very centre of a barrel of gunpowder with impunity. I have not tried the experiment myself. I will, however, break an incandescent lamp before you in the centre of this mass of tow. The light goes out, you see, instantaneously, as the filament of carbon has been destroyed without setting fire to the inflammable material.

But the idea of there being eventually an explosive mixture of hydrogen and air in the balloon, through diffusion of gases, is one which need not be considered; first, because these balloons are tied up at the mouth; secondly, because there is not much spare lifting power to economize weight of apparatus for military service, and the balloon would fall before these conditions would arise.

I will show you one more of this series of experiments. The idea of a naked electric spark occurring in the midst of the gas through some faulty connection may seem alarming, but, for the same reason I have before mentioned, the non-inflammability of hydrogen gas *per se*, the spark can exist harmlessly. Here I have a naked electric discharge, sparking away harmlessly in the centre of a third globe filled with coal gas. However, in the case of the lamp holder and connections provided, matters are so arranged that there is no sparking. As the cable is thoroughly well insulated, there is no chance of a spark occurring at the mouth of the balloon. I think these experiments will have shown conclusively that placing the in-

candescent lamps inside the balloon is unattended with danger. With such a system of signalling as the translucent balloon affords, the signallers are fairly independent of the configuration of the country; for instance, if a hill or a wood intervenes between two signalling parties, each can have its electric balloon and communication can be established. In the case of the navy it may often happen that a ship is stationed in a bay surrounded by cliffs, and the officers on board may wish to communicate with another ship on the other side of the cliffs which form the bay. In such a case the ordinary signals would be unavailing, while if each ship had a balloon the respective officers could freely converse. By means of the electric balloon it would be possible to signal from below the horizon. There has not, as yet, been any experiment with these balloons from a man-of-war, but I am exceedingly anxious that some experiments should be conducted.

Concerning the chances of a balloon being fired at and hit by the enemy, the experiments which took place at Lydd and in Germany have shown that it is almost impossible to hit a balloon until its distance and height are known. With regard to small arms fire, the damage done by occasional bullets could easily be repaired. It is not very easy to bring a balloon down by a few bullets, especially if the lower portion of the balloon is hit, as the following experiment will show. Here is a model captive balloon. I am going to pierce the envelope with this needle, which corresponds to a bullet shot in a large balloon. You see the balloon does not fall. With regard to artillery fire, before the enemy has the information to adjust his guns to the angle of elevation, the balloon could give its message and come down again.

Wind is usually considered the bugbear of captive balloons, and naturally, in the case of human beings having to be suspended in the air, it is a serious difficulty, and limits their use. My experience, however, with these balloons in which the question of human life is not involved, is that they can ascend successfully and usefully on a large average of days in the year, even in our breezy island, about the worst place in the world for captive balloon experiments. As an example, during a whole month of experiment in July, the balloon went up every other day without the use of guy ropes. Four days only out of the fifteen were calm. With a skilful use of guy ropes, an experience which has been gained since those early experiments, the balloon could have gone up every day. During a consecutive period of two years and two months I can number thirteen times on which dates have been fixed in advance, sometimes as long as six months, and the ascent has taken place on the day arranged, guy ropes having only been used on one of these occasions, when the balloon was sent up at an evening fête at Bradford. The balloon enclosure was awkwardly surrounded by firework set pieces, and a stiff breeze was blowing, but with the use of the guy ropes the balloon was steered clear of the obstructions, though it was not an easy matter.

The most severe test, however, of the use of these balloons in windy weather was the day that I had undertaken to exhibit the latest improvements in the apparatus at the Stamford Bridge Grounds to General Prince Edward of Saxe-Weimar and a number of

military and naval experts. On that evening there was half a gale blowing, and it was the opinion of balloon experts that it was too unfavourable an evening to carry out the experiments at all. The balloon, however, was filled; it ascended and signalled. No damage was sustained by the balloon, lamps, or fittings.

On the switchboard, which contains the signalling key, there is, as I have mentioned, an arrangement by which the lights in the balloon can be turned on continuously, thus. The continuous illumination has its uses. It would be invaluable as a preconcerted signal or as a point light to concentrate troops at night to a given place. An officer of the Royal Engineers who was in the late Egyptian Campaign pointed out that in this latter capacity such a balloon would have been invaluable in the night parade before marching to Tamai at Suakim.

Continuously illuminated, the balloon would also be serviceable as a light for working parties because of the diffusion of light from the large surface. Although there is only a comparatively small candle power in the model balloon, it is capable of diffusing a considerable amount of light in the theatre. At the trial of the balloon at Chatham by the Royal Engineers on October 28th, 1885, its capabilities in this respect were tried in the following manner:—The balloon was sent up some distance from the ground in a dark field, and the "Times" newspaper was distinctly read by its light at a distance of 120 yds. At a height of 500 ft. from the ground the illuminated balloon cast a distinct shadow on the ground of the bystanders below. This secondary use of the balloon was again demonstrated at the Cork Military Tournament last August, when the balloon took part in a sham fight. The balloon advanced into the field accompanied by the Royal Engineers, and by its light alone the Engineers built a bridge over the river. When the bridge was built, the balloon ascended and signalled "Bridge repaired and ready for passage of all arms." The troops crossed the bridge and attacked the fort. When the fort was taken, the balloon signalled "Enemy defeated and fort captured," thus showing its double uses.

It may, perhaps, be interesting to briefly state the history of the invention. It was first exhibited in model in the War Department of the Inventions Exhibition, and while on exhibition there the method was referred for Government trial under a Committee of the Royal Engineers at Chatham. During the time the model was being exhibited at South Kensington some experiments were tried with a balloon of between 4,000 and 5,000 cub. ft. capacity at the Albert Palace, Battersea. The first trial of the British Government took place at Chatham in the October of 1885. As a result of these experiments I received an order to supply apparatus to the Royal Engineers at Chatham. A second trial of the invention took place in January, 1886, at Aldershot, under the superintendence of Major Thrupp, the late Inspector of Army Signalling. On this occasion the experiments were conducted during a snowstorm and mist—not the most advantageous conditions for trying a new system of signalling. A party of signallers was stationed 3 or 4 miles from the camp, and, in spite of the mist and thickly falling snow, the signals were read and answered.

This was a remarkable test, because the balloon, on its descent, was found to be crystallized with snow, and much of the light must have been obscured, first, by the falling snow and mist, and secondly, by the crystalline coating on the balloon.

In the autumn of 1887 the Belgian Government adopted the system, and, at the request of the War Minister, General Pontus, I went to Antwerp to conduct the experiments on the first night on which the apparatus was used. The experiments were carried out at Berchem, in the fortifications outside Antwerp, on the evening of October 26th, in the presence of General Pontus, the Minister of War, General Wauvermans, the Inspector-General of Fortifications at Antwerp, and various other officers, including delegates from Russia, Holland, and other countries. The officers were stationed at various points of the fortifications which were on the telephonic circuit, and messages were sent by balloon to them. The first message sent was "Porte d'Hérenthals de Berchem, voyez vous distinctement signaux Bruce, répétez la dépêche par téléphone. Signé, General Wauvermans." This was distinctly read and telephoned back; also the second message, sent by the Minister of War: "Envoyez un bataillon au Fort I. Signé, Ministre Guerre Pontus." A third message, sent to the Caserne of Telegraphists, was equally successful. The telephonic stations were comparatively near, being only at a distance of about 5 km., the object that night being to test at once the distinctness of the signals by placing the observing stations on the existing telephonic circuits, so that each message might be speedily repeated back, but the night was an ideal one for signalling, and it was understood that the illuminated balloon was seen to an enormous distance. A company was also on the look-out at the top of the tower at Notre Dame at Antwerp (4 km.), and it distinctly read all the messages sent. These official tests in Belgium, in the course of which not one single hitch or error was made by the signallers, though it was the first time the signallers were handling the special key, bear out, I think, the claim for distinctness attained by placing the lights inside the balloon. In the early autumn of the same year the Roumanian Government sent a special deputy to London to see some experiments with the system at the Lillie Bridge Grounds. These took place under fairly good meteorological conditions.

Such are the principal experiments that have been carried out with the apparatus. They have taken place under a variety of circumstances, adverse and favourable. Perhaps, I may venture to hope, they have proved the utility of the system and may secure for it a more general adoption by our own Government.

Before concluding this paper you may think that I ought to mention some particular occasion in history when such a balloon would have been useful. I do not think we need look far back to find such an example. It is but a few years ago that there was a General shut up in a besieged city with a few followers. Near at hand there were friends ready to help, but ignorant of the immediate necessity of their help. If from Khartoum there had arisen such an electric signalling balloon as I have described, its flashes of light in

the skies would have told the tale of the events below, and perhaps that heroic leader would have left Khartoum a conqueror, with his life spared for the future service of his country that he loved so well.

The CHAIRMAN: Before offering any remarks on this lecture, I will invite any gentleman who is conversant with all the processes which the lecturer has put before us, to offer criticisms upon it. It is a subject upon which I can only speak in general terms, for I feel that it would be presumptuous on my part were I to go into the details of a matter of which I have so little personal knowledge. The lucid manner in which the lecturer has put the subject before us induces me to believe that a great many of those who are present will go away feeling that they have during this short hour learnt a great deal of very valuable information, which has been placed before us in such a way that it may be understood by the very youngest member of the community.

Mr. BADEN-POWELL (Scots Guards): After the very able and scientific discourse we have just listened to, I feel some diffidence in rising to address you, more especially as I feel that there are certain objections to the system of signalling which we have seen illustrated. No doubt Mr. Bruce will be able to show that I am wrong in some of my opinions; but, nevertheless, I think it as well to bring them before the meeting. It seems to me that there are three great questions to be considered: first, is there any real demand for a signalling apparatus (other than the telegraph and existing lamp apparatus) for sending messages to a long distance at night? Secondly, if so, does this apparatus fulfil all the requirements, that is to say, is it a really thoroughly practicable means of sending a message? And, thirdly, could not other apparatus be devised for attaining the object which will be more portable, more simple, and more easily worked? The lecturer, speaking of rocket signalling, says, "though useful for a preconcerted signal, it cannot be said to be well adapted for conversation by sea or land." This seems to me to be a very important point, whether this apparatus is to be used for signalling long conversational messages by the Morse alphabet, or whether merely for preconcerted signals, that is to say, to signal some one word or a few dots or dashes meaning some prearranged message. If it is to be used for signalling long messages, I see two objections. First of all, unlike the telegraph or lamp signalling, the message might be read by the enemy. Of course, that need not always be an objection, but very often it would be a great objection to the use of the apparatus. Secondly, from what I myself have seen of the working of this apparatus on two or three occasions, I should have thought it would have been very difficult to read a long message, especially at a long distance and during windy weather. The balloon sways about a good deal, and if a telescope had to be focussed on the balloon, I think there would be very great difficulty about it. I do not know whether Mr. Bruce has ever succeeded in sending a message to a great distance, say, 5 or 6 miles, on a windy night, that has been correctly read. Of course, a short message, just one or two words, can very often be more easily sent than a longer message. And there is another thing that strikes me. The lecturer talks of the filament in an electric light taking some few moments to go out entirely, so that the light is not very sharp when turned out, and he says, "this is entirely obviated when it is placed inside the balloon." I should have thought it would have had rather the opposite effect, that the fact of the material of the balloon being interposed would rather make the flash less abrupt; hence slow signalling. If, on the other hand, the chief use of the apparatus is to merely flash out some preconcerted signal, I should have thought that rockets, or some similar apparatus, would have been infinitely simpler, more portable, and less dependent on wind and other circumstances. Perhaps I may be here allowed to refer to an idea of my own which I brought out some years ago. The apparatus consists of a small paper fire balloon, say, 6 or 8 feet in diameter. When it is desired to send a message, some beads made of a brilliant quick-burning composition are strung on a piece of quick-match, leaving intervals, and using large and small beads to make the corresponding flashes. The balloon is inflated by burning spirit, or even straw or wood. These small balloons can be inflated in a house, tent, or other shelter in windy weather. The message string is suspended

below the balloon, and a time fuze attached. The balloon is sent up free, and the message is flashed forth. I have here a specimen of the beads on the string to show what I mean. This apparatus is very portable; one man can easily carry it, and with it not only can one preconcerted message be sent up like that, but a few words can be sent up at one time, and those could be answered from a similar balloon from another part, a second balloon sent up, and so on. To return to the apparatus described by the lecturer. He suggests other uses for the balloon. He mentioned it as being utilized as a point of light to march on, but I think the occasions would be very rare indeed on which it could be made of use. Night marches are usually conducted with great secrecy, and no lights are shown, and, as a rule, they would generally be in the direction of the enemy, so that the light would not be in advance of them. With regard to his suggestion that it might be used as a means of lighting working parties, though I cannot speak from experience, I should have thought the illumination would have been better accomplished if the electric lights, instead of being placed in the balloon, were distributed on poles about the ground. It certainly strikes one that that would be better. Then the lecturer suggests having special balloons of about 4,000 cub. ft. for this purpose. Would it not be much better as we have got balloons of 10,000 cub. ft. to use those, which would also be useful for other purposes, than to have special balloons for this purpose alone? There need not necessarily be a greater quantity of gas carried, because a balloon of 10,000 cub. ft. might have 4,000 cub. ft. of gas put into it, and it would float just as well. The balloon is very light. On the other hand, if it were filled with a full complement of gas it would have greater ascensional power, and therefore be much steadier in a strong wind. Besides, though double the volume of the smaller balloon, it would not present anything like double the area to the wind. According to Mr. Bruce, his balloon measures about 20 ft. across, but the Government balloon measures only 27 ft. My general conclusions are, that this apparatus is cumbersome, that it would only occasionally be of any real use, but that, considered as part of the apparatus of ordinary balloon equipment, it might perhaps be useful. Mr. Bruce has studied the question for many years; he has experimented a great deal with it, and has doubtless heard many valuable opinions on the subject, therefore he is very much more competent to judge of the result than I am, and I shall be very glad to hear what he may say in answer to my criticisms.

Admiral Sir Erasmus Ommanney, C.B.: May I ask Mr. Bruce what space would all his apparatus occupy, and what space would the tubes conveying the gas occupy?

Mr. Bruce: The gas tubes are 8 ft. long, and about 5 in. diameter. The smallest balloons that could be used require about 14, whereas the 10,000 cub. ft. balloon would take 84. The smallest balloon filled with pure hydrogen could easily go up 1,000 ft.

Major-General W. L. Yonge: May I ask one question—whether there would be any possibility of that balloon being made use of in the day-time, and whether you could show a flash during the day-time? We know how you may use a flash in the day-time upon any reflecting surface, such as a window. It would very much enhance the utility of the balloon if you could make it an every-day and an all-day apparatus.

Colonel Thackeray: Some slight objections have been raised to the portability of this apparatus, but I think it is not unlikely that these can be got over. In India all sorts of delicate electrical instruments are carried about on the backs of mules and in rough carts, and difficulties of that sort are surmounted by experts, who design special leather covers and arrangements for carrying these delicate instruments. I think the electrical balloon apparatus, as described by Mr. Bruce, would, in the case of fortified positions on lines of communication, be of the greatest value. During the last Afghan War, on many occasions, although the signalling during the day-time was very efficient, by means of the heliograph, at night the want of an apparatus of this kind was constantly felt. On one occasion the Afghans had raised some of their sangars, or round towers, on the line of communication, and completely looked down upon the road, and caused considerable annoyance to the convoys. Sir Charles Gough, who was in command at the time, ordered that the Afghans should be driven from the sangars, and a small

column went up, drove the Afghans out, and destroyed the towers. Towards the evening signals were flashed from the post that the Ghilzais were coming on in three large columns, but although we could just make out the signals, the sun was going down, and it was not possible to read them very distinctly. Had there been a signalling apparatus of the character so ably described by Mr. Bruce, it would, on that and on several occasions during that campaign, have been of the greatest value.

Colonel Keyser, C.B.: As a signaller, and knowing something about the demand for signalling in this country and in our army generally, I can congratulate Mr. Bruce upon the very efficient system which he has evolved. I am afraid, however, that as far as we signallers are concerned, it would be impossible for us. It would do very well for the Royal Engineers for use with their train, or to be taken with electric telegraph train for use in some fixed position, but there is not sufficient mobility about it for us to use it with infantry or cavalry signalmen. Another fatal objection, in my eyes, is that it is so very slow; so slow that I consider it would be almost impossible to read. I have tried it myself, with Mr. Bruce's kind permission, at Lillie Bridge, and you saw just now, when the Sergeant-Major of the Signalling School, who, I suppose, is the best signaller in the army, tried to send a message, the dots to be made were so indistinct, that at a little distance they would have been quite lost. The reason, I think, is that you cannot get obscuration by cutting off the electric current. The lamp still continues to glow almost till the current is put on again, and the incandescence, unless you give it time, still shows a certain amount of light. The consequence is, that in order to be able to signal with this balloon, you must send your messages at a very slow rate indeed. Perhaps Mr. Bruce will kindly allow the Sergeant-Major to show what our ordinary lamp flashing rate is with the balloon, and then show what he would consider a readable rate with his balloon. It might, perhaps, be utilized for towns, or perhaps for communications from ships, or in any flat country, like the deserts of Africa. As the lecturer very eloquently put it, if there had been a captive balloon in Khartoum, and another at the headquarters of the English Army, a great advantage might have resulted. But I do not see how they could have carried that enormous weight across the desert; that would have been against it. However, if they had had it, I daresay they would have sent up communication where other methods of signalling would not have been possible, on account of their not being able to get any height from which to signal. Otherwise I am afraid that, as far as our army goes, for visual signalling it would be of very little use. Still, it is of very much more use to us than the method proposed by Mr. Baden-Powell just now—rockets. I have tried rockets. Rockets are an impossibility. You cannot localize them at all. You see a rocket in the air, but you have no idea from what part of the country it comes. It may be east, south, or west; you see it, but you cannot tell where it has come from. I congratulate Mr. Bruce very much upon the efficient working of his balloon, but I find fault with its great slowness and want of portability.

Captain Lionel Wells, R.N.: I ask leave to make one or two remarks in answer to Mr. Bruce's able paper, especially as regards signalling in the navy. As a matter of fact I think he rather ignores the value we attach to our search light, and has forgotten that the question of signalling from ship to ship has already been accomplished by our search light signalling. No doubt balloon signalling, if it could be carried out, would be effectual, but I think I have heard some stress laid on the difficulty of raising a balloon in bad weather. That would be the difficulty at sea. Of course there is no difficulty as to signalling over hills at sea; we also carry our dynamos and have every facility for this work. I am sure, therefore, that if we could raise the balloon, we could use it for signalling and observation. Another point to which I will draw Mr. Bruce's attention is, that we have lately been able to get out a signalling lamp for long-range signalling very much on this principle, and although Mr. Bruce looks forward possibly to the time when we can arrange our carbon filaments in our lamps so as to get the proper candle power, I think we have done so hitherto with the present manufactures of these lights. No doubt there is the difficulty that you cannot get rapidity with distinctness of signalling, but I do not go quite so far as the Colonel (Colonel Keyser) who last spoke, because the signalling language in the army is quite a different thing from the signalling language in the navy, as at present existing, in this way, that you will probably do a

column of the "Times" while we are doing a few lines. The facilities he has for doing this are much greater than with us. We have to signal from a moving to a moving platform. Again, we must make certain of our signals; there is absolutely no room for any disagreement between the signaller and the signallee. Besides, our men are not educated to do this rapid signalling. The signalling lamps we have give us every satisfaction at present, arranged on an apparatus similar to what you have inside that balloon. I would ask Mr. Bruce if he has ever done anything inside his balloon with the induction current. We see that his little induction current has the power of producing a spark, and it is quite possible he might minimize the weight carried, by having a few batteries and arrange an induction coil and spark inside the balloon. That may or may not be, but it seems to me the glow would be perfectly apparent for many a mile, were it small or large, because a balloon in the air, lit up however meagrely, so to speak, would, I am sure, attract attention, especially if one were to look out for it with binoculars. I do not think it would be necessary to have immense candle power, in fact, to make it a small moon in the sky. With these remarks I will thank Mr. Bruce for his paper.

Admiral Colomb: I am called upon to say a word, but you see I am altogether of the old school; all my acquaintance with signalling dates from thirty to thirty-five years ago. We had no satisfactory electric arrangements in my day, and therefore I am really not competent to say anything useful about the particular system before us. But as the Chairman has asked me to say a few words, I will allude to one or two points which have struck me. I notice the absence of any mention of comparative experiments. I have not myself very much experience of the use of the search light—the electric light from the arc lamp thrown into the sky—but I have seen it used on almost cloudless nights, and I did not gather from what I saw that clouds to any great extent were a necessity. I have seen it used from below the horizon, as spoken of, and I should have thought that taking it all round it would form a much more efficient system of signalling than the illuminated balloon. Thirty-five years ago I made some experiments with lights inside translucent material with the view of exhibiting signals by means of illuminated forms. I made some translucent forms and placed light inside them; then I tried the same lights without the translucent form. I found on covering the lamp with any substance which was sufficient to exhibit the illuminated form, that it was very much more powerful without it, and could be seen to a much greater distance. I had a sort of idea that as the light alone was a mere spot, the illuminated form, such as the balloon that we have seen, would be visible to a greater distance from the extension of the size, which would more than compensate for the want of brightness of the light; but as far as my experiments went, they led me to drop altogether the idea of illuminating through translucent material. The lecturer no doubt knows that the idea of using balloons to give height in order to signal is comparatively old; we had in this theatre, balloons similar to these, I think, in the year 1863. The proposal then was to use the balloons for day signalling. They were to carry up flags as used in the navy. The balloons were intended to be of very small size, only sufficient to carry up the light flags, and you hauled your balloon down with your series of flags in exactly the same way as you hauled down the signal flags by their halyard on board ship. I have been excessively interested in the lecture and much taken with the admirable care bestowed on putting every point before us, and leaving us not in the least in the dark as to how everything is produced and as to the lecturer's own ideas on the subject. I think he is to be congratulated on his skill as a lecturer, and I wish myself I could think, after the military opinions we have heard, that his system would make as much progress in the British Army as it deserves.

Admiral Sir W. M. Dowell, K.C.B.: Might I just say one word with reference to signalling by the search light. Ten years ago, during the Egyptian campaign, I was stationed at Aboukir Bay, in the "Minotaur." I was surprised about 3 o'clock in the morning by the officer of the watch coming and reporting to me that a signal had been made that the "Orontes" had arrived at Alexandria. The signal was made by the "Inconstant," lying in the outer roads, and between us and the "Inconstant," a distance of 18 miles as the crow flies, there was the high land of Aboukir Point. This signal was made by the search light flashing in the clouds.

It was simply the rays of the search light showing over the high land. The signalling was clearly read and was perfectly correct; first the "Minotaur's" pendants, then the signal, which was answered by the "Minotaur" in the same way.

Mr. ASTON LEWIS: May I ask Mr. Bruce whether he has ever made any experiments as to the feasibility of using some sort of shutter apparatus, or collapsible drum in daylight, worked on a captive balloon by electricity.

Mr. E. S. BRUCE (in reply): Mr. Baden-Powell seemed, in his remarks, to imply that it would do as well to have a 10,000 cub. ft. balloon as a 4,000 cub. ft. Now, I think, directly you get to any size beyond the 4,000 cub. ft., the difficulty becomes very much greater proportionally. For instance, on the occasion of the windy night, which I spoke about in my lecture, at the Stamford Bridge Grounds, I wished, if possible, to get the balloon up. It was really the opinion of the balloon authorities that it was impossible. Lieutenant Jones telegraphed to me to the effect that it would be quite impossible to get the balloon up, but I was very anxious, if possible, to do it. I had two balloons provided, one of 3,200, and the other of 1,600 cub. ft. I knew that if I could get up the 3,200, I might get up the 1,600. I had both ready to fill at the very last moment, watching the wind. I gave up the 3,200 and had my small one filled. I did not wish to use it, but I carried out what I had undertaken to do that evening by using the smallest of my balloons. Mr. Baden-Powell said he did not think it would be seen well on a windy night. It was seen for 6 miles certainly, although the balloon was very much blown about, for there was half a gale blowing that evening. Then about Mr. Baden-Powell's fire balloon. A fire balloon is only of use on the calmest evening possible. It would be a most difficult thing to get a fire balloon off if there were any wind blowing at all. I do not think that it could be used successfully unless it was quite a calm night, and certainly, in this country, I have only had, I may say, two calm nights since I have carried out my experiments. Nearly every one of the experiments I have mentioned has taken place in considerable wind. Of course, on the Continent, you get a much better chance. The first time I tried on the Continent I had a calm night: in this country I never expect a calm night. Then about the flashing being not so clear when the filament is inside as when the filament is outside. I think the reason of that is because we never see the actual filament at all when it is inside a translucent material. We never see the glow coming gradually to an end. It is spread over the large surface; whatever the reason is, certainly in practice the messages are distinct when the light is spread over a large surface, comparatively, to what they are when it is outside. In Belgium I took that apparatus as well, showing the lights without a covering. After they had seen them inside the balloon they had that up, but they would not look at the lights outside after they had seen them inside the balloon.

Mr. BADEN-POWELL: Have you ever read a message on a windy night at any long distance?

Mr. BRUCE: I do not think much beyond 5 or 6 miles. I always found the Government was very kind with the messages they gave me. They gave me such short distance messages. In a clear atmosphere like that of Egypt, with enormous candle power, my idea is that for 40 or 50 miles the balloon could be seen. I was asked whether the balloon was of any use by day. Of course this actual balloon is not, but I may say now I have devised a method of signalling by day. I have not yet worked it out. It will form the subject of a patent, and therefore I cannot at present enter into it, but I have devised what I think will be a very efficient method of day signalling. I cannot, however, hold out the hope that the day signalling will go to so great a distance as I think the night signalling can. I think it would be a useful apparatus; but this system has taken a great deal of my time, and has also cost a great deal, and I should like to see one system afloat before I embark on another. I was quite prepared to hear Colonel Keyser object to the signalling being slow. I know it has to be slow with the present filaments we have got. I said in my lecture that we shall be able to get quite a different thing altogether in a few months' time—a filament so fine that I think the speed will be very much increased beyond what it is at the present moment. I would not dare to try experiments with the fine filament incandescent lamps at present, because Messrs. Edison and Swann are so very much down upon one; at least, I should not mind

trying experiments myself, but I should not show them at present. There was a lamp a little time ago that had a very fairly fine filament. It was really a beautiful hair filament; it could hardly be seen, and doubtless they will be made still finer. I think such a filament would give a very good result to quick flashes. I quite agree that quick flashing is desirable, but on the Continent they never seem to mind how slow you go. In Belgium it did not matter a bit; they pound away, and seem to think the slower you go the better it is.

Colonel KEYSER: The Sergeant-Major said he could read about four words a minute; we never read less than twelve.

Mr. BRUCE: I do not think the idea is to do away with the ordinary method of signalling, but rather to have an additional thing for altitude when you could not get the other method up into the air. About its use in rough weather, I would rather have a wind on board ship than on land. On land the balloon would be blown down on the ground; in the case of a ship I should give the Captain orders to steam as hard as he could with the wind, and then I should think the balloon would keep up. As regards the high voltage experiments, it seems to me that mere sparking would give very feeble results compared with incandescent lights. Of course the apparatus would be elaborate, and would be more likely to get out of order; but everything is worth trying. As to a shutter apparatus or a collapsible drum with the balloon, I have not yet actually tried that with electricity. The system I am thinking of for day signalling would not involve electricity at all, but it would be something of that kind. I cannot quite go into that at the present moment.

The CHAIRMAN: We have all listened to the lecture with the greatest interest, and also to the discussion which followed, and which has brought out some strong arguments against the invention, and many that are in its favour. I think the lecturer's strong point is the increased altitude to which he has succeeded in raising the power of signalling—a matter of the utmost importance when certain conditions are considered. For example, Colonel Thackeray alluded to the lines of communication in India. I cannot conceive anything more calculated to inspire confidence than the certainty that at every important post there is a means of not only telegraphing by night, but telegraphing with that sense of security on the part of the operator which is so essential to give confidence to those who receive the message. I think, therefore, that as to the value of his system of signalling in a beleaguered place or a fort on a line of communication, you will agree with me that the lecturer has quite made his point. We can readily understand how, in great cities where it is of importance to communicate to a distance, this system might have great advantage. During the late war between France and Germany, when Strasbourg and Metz were both surrounded, Bazaine was endeavouring to communicate with MacMahon's army marching round towards the north. For this purpose he endeavoured in vain to find a coign of vantage from which he could signal. Now, if he had been able to raise a Bruce balloon to a height of 1,000 ft., and keep it there for a length of time, he might have been able to have announced the condition of the garrison and his intention as regards breaking out or surrendering. In like manner, at Strasbourg, where, as you know, the Cathedral is the highest building in Europe, a night-signalling apparatus, 500 ft. above the steeple, would undoubtedly have been of very great use in showing the state to which the garrison was reduced. I think, therefore, that Mr. Bruce has certainly made good the claims of his system to be held worthy of the attention of those who are in high office, and whose duty it is to look after such matters. With regard to the sea, I fear that the search light would quite overpower that shown by the captive balloon. The evidence that has been given to us to-night shows that the search light, on almost every occasion, has been able to flash signals quite sufficient for all naval purposes; and one speaker alluded to that most important case of all, where two ships, with mountains between them, were able to communicate by flashing the search light alone. Therefore, although I feel sure that it might be useful in the navy, it will not be so applicable to that service as to our own. Mr. Bruce has given a great deal of time and attention to this most important subject, and I feel that we have learnt a great deal from the extremely careful manner in which he has set it before us. I have, therefore, great pleasure in returning him our best thanks.

Friday, February 3, 1893.

Major-General R. N. DAWSON-SCOTT, Commandant, School of Military Engineering, Member of Council, in the Chair.

THE TACTICAL EMPLOYMENT OF ENGINEER FIELD COMPANIES IN COMBINATION WITH OTHER ARMS.

By Captain G. K. Scott-Moncrieff, R.E.

In "The Tactical Retrospect of the Campaign of 1866" the author observes: "The next campaign will show us this fourth arm acting in rivalry with the others in the battle." By "this fourth arm" is meant the field engineers or sappers or pioneers of an army. The prediction above quoted was fully borne out in subsequent European wars. In 1870 the work of the German engineers, not only at sieges and on the line of communication but in actual combat, contributed freely to the German successes; and in the 1877 campaigns, both in Bulgaria and Armenia, the work carried out by the engineers in action on both sides forms one of the most conspicuous features of the campaigns.

The more recent development of tactics consequent on improved firearms has not tended to decrease the importance of this tactical question, and consequently we find that in most European armies the matter is now carefully considered. It may therefore be worth while for us to devote some little attention to the subject.

A British division is composed of the following fighting troops:—7 battalions of infantry, 4 squadrons of cavalry, 3 batteries of field artillery, and 1 field company of engineers. The tactical relation of the three arms first mentioned is a subject carefully considered and constantly practised in our Service; it is a matter of the highest importance, also, that every officer who is entrusted with a mixed command should know something about the organization, not only of his own arm, but of the other two. The object of this paper is to endeavour to prove that the engineers of a division, or an army, are not a body requiring to be dealt with differently from other troops, but a fighting weapon possessing certain definite value *as* a weapon, and requiring to be used on the same broad principles as other arms.

To realize the value of this weapon it will be necessary first to state briefly what the organization of the engineer field companies is, then to detail their duties, and then to show how those duties should in combat be combined with the work of the other arms.

In considering the question of British organization, and for present purposes, we may set aside the fact that in the Indian Army there are six battalions of pioneers, organized on the battalion system. Many distinguished officers have expressed their admiration of these pioneer battalions. I may be permitted to add my testimony to their worth, as I was at one time Staff Officer of a brigade of three battalions of them; and I regret that they are not affiliated in any way to the Royal Engineers, inasmuch as they are certainly "technical troops." In time of war they are used as infantry, armed as infantry, and their organization is that of the infantry battalion. So that they do not come under the consideration, properly speaking, of the present paper.

In time of war the strength of each field company is 1 Major, 1 Captain, 4 Subalterns, 210 non-commissioned officers and men, and 69 horses, including officers' chargers. The interior economy is similar to that of a battery of field artillery, the officer commanding the company exercising a very independent command, and being absolutely responsible for drills, technical instruction, and discipline, as well as for pay, clothing, and equipment of all kinds. The men are divided into the sappers and the drivers; the former are by far the larger proportion. They are enlisted all over the United Kingdom. Each man must have a specified trade (connected with building work for the most part) and be good at that trade. Each man must be 5 ft. 6 in. at least in height, and have a chest girth of 34 in. These conditions, coupled with the fact that, before being drafted into the field companies, each man goes through a year's training at Chatham, keep out of the ranks the immature lads complained of in the infantry. It is not possible for an artizan to be proficient at his trade while still a young lad; consequently the average age in the engineers is higher than in other branches. A company of sappers is therefore composed of better raw material than a company of infantry, both in physique and intelligence. The sappers are armed, equipped, and drilled as infantry.

The drivers, or mounted portion, are smaller and lighter men than the sappers. They need not have any particular trade, and they are not instructed in the technical duties of engineers. Their business is to look after the horses and mules of the company transport.

The extra pay which all ranks receive attracts to the ranks of the engineers a very good sort of recruit, capable of being highly trained and of using his brains well. This has an important bearing on the question of military efficiency.

The companies are equipped with every sort of implement that can be of use either in the constructive or destructive work of the military engineer. This matter has received the greatest attention in our army.

To carry the equipment, wheeled transport is the most economical and convenient form of carriage; but, as wheeled vehicles cannot travel in all situations, pack animals are largely, and in some campaigns have been exclusively, employed. Our present system is to employ a few pack animals, but to carry the bulk of the equipment

on wheels. Of the 69 horses in a field company, 12 are officers', 5 are riding (non-commissioned officers'), 6 are pack, and the remainder are for draught.

The vehicles are as follows:—2 pontoon wagons, 5 forage carts, 1 forge wagon, and 4 tool carts. The latter are peculiar to the engineers. In appearance each cart resembles an artillery ammunition wagon. They are intended for carrying out all the necessary tools for the work which the sappers may have to carry out in the field of battle. For this purpose the carts are so designed as to be capable of going over rough ground, and of transporting at a rapid pace a limited number of men, sitting on the carts, to carry out any operation, such as the blowing up of a bridge, where time is of importance. These tool carts are the only vehicles brought on parade in ordinary circumstances. They are drawn by four-horse teams, but are so arranged that each double cart may be divided into single carts (each like an artillery limber), drawn by a pair of horses.

All the officers of field companies are mounted, not for parade purposes, but because in most operations where their men are employed they have to go on ahead, examine the ground, make rough estimates of the men and tools required, and generally make all arrangements of such a nature that when the men arrive on the scene of action there may be no unnecessary delay, where time is often of paramount importance. It is evident, therefore, that the officers must be active horsemen and well mounted.

Before leaving the subject of organization, it is not irrelevant to mention that in time of peace both officers, men, and horses are largely employed, for the benefit of the British taxpayer, on the public works. For four days a week on an average the men are employed building, repairing, or supervising the construction of barracks and other military buildings. This is a public economy, it is an advantage to the individual men, and inasmuch as they are employed, generally, under their own officers, there is the great military advantage of constantly associating together on the works of peace those who must work together in war. From this work officers get to know the capabilities of their men, and the men know their officers. It is when thus employed that other branches of the army are most frequently brought into contact with the engineers, and there is, perhaps, not unnaturally, a prevalent idea that the duty of repairing barracks, &c., is the first and only duty of the sapper. This is, of course, quite erroneous.

Every week the men are drilled once or twice under their own officers. The total amount of drill in a year, considering the British climate, is not great, but there is no doubt that it is sufficient to keep the companies at a high level of smartness. No amount of smartness on parade, however, can make up for negligence in technical training, and for this most essential duty thirty working days each year are allotted. The course of instruction includes all the technical work demanded of engineers in modern warfare (except telegraphy, which is the work of a special branch). To the officers of the company this annual course is as important as it is to the men, as they

have to plan, arrange, and calculate the work to be done, as well as supervise its execution.

Thus briefly we have considered the organization and training of this tactical unit in the British service; let us now consider its duties.

The duties of engineers generally in war are of three classes:—

1st. *Duties in Camp.*—The construction of huts and other shelters for troops, the arrangements for water supply, and for sanitation generally.

2nd. *Duties on the March or Line of Communication.*—The making and repair of roads and of bridges, the removal of obstacles, construction of railways and telegraphs, of piers and landing stages, or the destruction of any of the above; also the surveying of the country.

3rd. *Duties on the Battle-field.*—The preparation of positions for defence and the strengthening of natural or artificial posts (such as buildings, villages, woods, &c.,) which may occur in the theatre of operations, whether for attack or defence. Also in the attack, securing any advantage gained, constructing entrenchments and removing obstacles in the field. In sieges the engineers' duty is to direct and execute all works of attack or defence.

Now it is evident that the first and second classes of the above duties are not dependent on the operation of other troops for their proper performance. The sinking of wells or the building of bridges may be quite well practised by the engineers by themselves; they may be even carried out by civil labour. In some campaigns the construction of railways, telegraphs, and similar work has entirely been done by civilians. These duties, therefore, are not strictly speaking tactical operations, though they may be under certain circumstances closely allied with tactics.

But when we come to the third class of duties, we must have them carried out in co-operation with other arms if there is to be any advantage in them, and the labour spent is not to be entirely wasted. It has been the besetting sin of the engineers of all armies that, from the fact that many of their duties may be carried out independently of other troops, the idea becomes established that all their duties are equally independent. They thus come to play at soldiers in a little corner by themselves, to the great disadvantage of their power when the day of battle comes.

With regard to siege works, it must be remembered that the tendency of modern warfare is to carry out operations swiftly, and thus the protracted methods of attack by means of trenches, saps, and mining are too slow. It is probable that in the future large fortresses will be invested and blockaded, as Metz and Paris were in the Franco-German War, and not attacked in regular fashion. The increased power of garrison artillery will make the circle of investment wider than formerly, but nevertheless it seems to be generally accepted by the best authorities that the efforts of engineers will be in future directed towards the prevention of the enemy getting out of, rather than towards their own side getting into, a fortress.

When we come to consider *localities*, such as villages, farms, buildings, woods, quarries, &c., the case is different. These have formed

most important points in battles in the past, and are likely to prove of equal, if not greater, importance in future. Such localities, of some sort or another, will occur in every battle-field; their attack and defence therefore form an important feature in the tactics of all arms, and it is our purpose to consider what part the engineers of an army should take in such combined tactics.

An army operating in the field against an enemy may be acting either on the purely defensive, or on the partially defensive, or on the offensive. In each of these three methods of operation the engineers have their distinct duties.

To act on the purely defensive is of course open to many disadvantages. The power of the initiative is abandoned, and the moral disadvantage is great; but, nevertheless, circumstances may arise when it is necessary, and therefore the duties of all troops in connection therewith must be carefully considered. History, of course, teems with instances of the purely passive defence, instances, too, where such action was the turning point of a campaign, and where nothing else would have been the right thing to do. Again, it does not always follow that because a force is acting on the defensive it has lost moral power; for instance, the German armies before Metz and Paris were, strictly speaking, acting on the purely defensive during the investment of those places, and yet there can be no doubt that they had the moral ascendency over their opponents.

The tactics of the engineers in the purely defensive may perhaps be best illustrated by reference to the valuable instruction which took place at the Curragh in 1890. Here a brigade of infantry, with a small force of cavalry, engineers, and two guns, was ordered to occupy and defend a position covering a village, executing fully the various works required. The general plan of defence was prepared by the General Commanding the division of which the infantry brigade was a part, and was as follows:—The outer line of defence was a line of breastworks resting on a small redoubt at one end and an epaulment at the other, the second line was a powerful redoubt with two strong block-houses, and there was a third line to be made use of only in the last extremity to cover a retreat. The block-houses had already been built by the engineers, but this circumstance was accidental; had there been any necessity they might have been erected concurrently with the other defences. The organization of the brigade, and the details of how the work was to be carried out, were left entirely to the Brigadier.

The various arms were then distributed as follows:—The cavalry was pushed out to reconnoitre, to discover the enemy and his dispositions. The infantry furnished a covering party of about one-third its total strength, which, with the artillery, occupied a favourable position to guard the approaches to the work and hinder any molestation. The remainder of the infantry and all the engineers did the work of entrenchment. The outer line was divided into two parts, each of which was placed under a battalion Commander, while the work on the second line was placed under the Commander of the 3rd battalion. These infantry officers were entirely responsible for the laying

out and execution of the trenches, for the distribution of their men, and for the quantity of work done. They were, however, supplied with tools from the engineer depôt, which was in rear of the position, and the senior engineer officer, who was, naturally, in consultation with the Brigadier as to the general defensive arrangements, visited the whole of the works from time to time to assist infantry officers with his advice in matters of technical detail. The men of the engineers were employed in the laying out of the second redoubt (assisting therein the Commander of the 3rd battalion), erecting profiles, constructing revetments, constructing field casemates, placing obstacles in front of the position, and especially laying out land-mines to be fired electrically from the main position. These operations were carried out on several successive days, the programme being varied to suit alterations in the general idea.

It is worth noticing that in these operations the engineers made all arrangements for the supply of tools. Circumstances might arise in which this would be advisable, but as a rule entrenching tools should be supplied by the corps using them.

The Divisional General, in order to test the capabilities, relatively, of men accustomed to work with entrenching tools as against others, gave orders on one of the days that a squad of sappers, not picked men, should be given the same tasks as the infantry, working in the centre of the line between two infantry companies. For various reasons, which need not be detailed here, all the troops working that day were doing their very utmost. The test was therefore a very fair one. The section of sappers, working under an energetic young Subaltern, turned out in one relief (four hours) work which bore to the infantry work the proportion of 10 to 7, or about 30 per cent. more.

Broadly speaking, therefore, the *rôle* of the engineer soldier in the passive defence is the construction of such works of defence as are of an elaborate nature, and which do not come within the curriculum of the infantry soldier's training, and also he has control over all mines and demolitions.

In the case of the *partially defensive*, it is evident that, unless there is a great deal of time to spare, infantry soldiers cannot be largely employed on the work of entrenchments. Their physical and moral energies are required for other work, and it must be the aim of the Commander to conserve those energies as much as possible. With the engineers the case is different. Their superior power of rapid work may here be very legitimately utilized on the simplest forms of earthworks, and thus they may become a most valuable auxiliary to infantry or artillery by reason of the protection they can afford at the points where they work. It is needless to say that such points must be ordered and settled by the Commander of the force himself. "It does not do for an engineer Subaltern, however gifted, to settle the position of an entrenchment for an army," was the remark of a distinguished General to a young engineer officer who was actually charged with the duty of selecting a position for the rallying of a force. This is a matter which must be evident to every military student.

In our peace manœuvres the positions of shelter trenches are

marked by canvas screens or lines of tape. Of course if these are to be of any value, the troops who are supposed to have made them must be in proportion to the length of line entrenched, and must have been extended on the spot for a sufficient length of time to enable the proposed work to be executed. These very necessary conditions are not always insisted on.

It is in this form of action—the partially defensive—that the mobile power of the field companies is most conspicuously useful. We have many instances in warfare of mounted troops seizing an important point in a battle, but being unable to hold it because there were no tools up in time. A dozen sappers with their tools would have made all the difference. Here, then, is the place for the tool carts being sent as fast as the horses can travel, carrying on them a sufficient number of sappers to commence operations. It must be remembered, too, that in such cases engineers, unlike artillery, can travel without escort. Every man is armed and trained in the use of the infantry weapon. They have nothing to fear from hostile cavalry.

The *rôle* of the engineer, generally, in the partially defensive combat is to strengthen certain points artificially, in such a way that they may be held by a small force, and thus enable the greater numbers to be free for offensive movements in the counter-attack. These points become pivots, frequently, round which the combat turns. Or they may, by creating obstacles on certain lines of approach, force the enemy to abandon those lines and confine his attack to other lines more favourable to the defence and consequent counter-attack.

Another valuable use of the engineers in this form of operation is in connection with rear-guard actions. In the cases of Münchengrätz in 1866, and at El Bodon in 1811, usually taken as types, it does not appear that technical troops were used at all, and yet no one who knows the tactical value of such troops can fail to recognize the immense assistance they would have given to the retreating forces, admirably as those forces were handled in other respects.

The following instance of a rear-guard action, which occurred at the summer manœuvres a short time ago, is a good illustration of the case:—A small force of a squadron of cavalry, two guns, a battalion, and a field company, the whole under the command of one of the most experienced officers in the English cavalry, was ordered to protect the entrance to a defile, in which, or, rather, beyond which, the main body of an army was retreating. The enemy was reported to be in considerable numbers. The ground towards the enemy was fairly open, with clumps of bushes, and, on the whole, rather favourable to the attack.

The Commander of the rear guard pushed his cavalry out, which, after forcing the enemy to deploy and checking his advance slowly, fell back, reporting the enemy's strength to be about three battalions, with a proportion of cavalry and artillery. Meantime, the other arms of the defence were disposed as follows:—The infantry and artillery were pushed as far forward as was deemed prudent, with orders to fall back slowly when heavily pressed. The engineers had been set to work on a line which rested on natural obstacles on either flank. By the time the infantry of the defence had been pushed back

to this point, closely pressed by the attacking battalions, sufficient time had elapsed for the construction of a useful entrenchment. The case demanded a frontal attack, and the Umpires judged that it presented an obstacle to the advance of the attack of so formidable a nature that, with the proportion of numbers, it was hopeless to attempt it. The rear guard had thus achieved its object.

A somewhat interesting feature in this case was that, owing to a mistake in orders, the engineers were, at the time of commencing operations, some $2\frac{1}{2}$ miles away. When the Officer Commanding heard that the presence of his company was urgently required, he put all the men into the general service wagons (which were at that time authorized for tool transport), and went off as fast as the horses could trot. In about twenty minutes they were in their proper place with the rear guard; the roads were muddy and heavy, and the horses covered with sweat and foam, but they arrived in time to save the day. Such a case might well occur in war.

A French authority has written on this subject as follows: "The retreats of Napoleon would not have been so disastrous if he had made use of field fortification for holding those positions whence he intended to take the offensive, or to cover his retreat. At Leipsic, for instance, it is almost inconceivable why he did not make use of them to cover the bridge of the Elster, his only line of retreat" ("Études sur l'Art de la Guerre," by General Burnod).

We come, finally, to the consideration of the tactical employment of engineers in the *attack*. Here we may again quote from a French author: "The essential principle in a battle, as in a campaign, is to be stronger at any given point at any given time; hence arrangements should be made to hold fast defensive points with few troops, so as to accumulate the greater number at the point where the supreme effort (of attack) is intended" (General Lewal, "Études de Guerre," quoted by De Lambre). This is evidently one of the uses of engineers in the attack, the principle of which we have already touched upon, viz., the strengthening of other parts of the field, so as to liberate as many troops as possible for "the supreme effort."

No doubt it is true that field fortification is less frequently used in the attack than in the defence, and yet, if the lessons of recent wars count for anything, they certainly teach us that, in the attacking columns themselves, there is a distinct place for the work of the engineers as for other arms.

It need hardly be said that an attack should always be preceded by the most careful reconnaissance. The dispositions of the enemy, his numbers, nature of his defensive works, and the nature of the obstacles in front of his position must be ascertained if any success is to be hoped for. In Skobelev's famous attack on the Green Hills at Plevna, on September 11, 1877, the reconnaissance was so imperfect that the existence of the great Krishin redoubt was unknown to the attack. An attack under such circumstances was doomed to failure.

Engineers would necessarily take part in such a reconnaissance, in order to ascertain what were the obstacles against which their energies must be directed.

Then, assuming that by means of cavalry, balloons, field observatories, &c., full information has been obtained, the next point is to decide the exact place where the "supreme effort" is to be made, and so prepare the rest of the field as to make counter- or flank-attack on the part of the enemy impossible. Then comes the artillery preparation. All the guns should be brought to bear upon the place where the assault is to be delivered, some time before the assault is made. If the guns are harassed by the enemy's sharpshooters, these must be driven back by skirmishers. Then comes the time for the assaulting columns of infantry and engineers.

The following is the method of attack proposed by the Russian General Dragomirov against fortified positions. First to push forward a chain of skirmishers to the best position it can find within short range of the enemy, and there to fire away as much as possible, attracting all the attention they can. With them may well be some proportion of engineers to enable them to get some sort of cover. "It is odd if there be not some remains of hedge, bank, or wall between 100 and 300 yards of the enemy" (Major-General C. B. Brackenbury). It would be the business of the sapper to utilize this.

Next comes the main body of the first line, "partly shielded from aimed fire by the chain," and therefore not subjected to severe losses. These must pass through the chain, and get to close quarters as fast as they can. "Engineers . . . should be among the first to be pushed forward" (General Brackenbury) to fight like infantry till they get to the enemy's obstacles, and then to ply axe, crowbar, guncotton, or whatever may be specially ordered.

For the further conduct of the attacking columns we must refer to General Brackenbury's book on "Field Works," a book which has a peculiar importance from the immense experience of the writer in European warfare. What we are at present concerned with is the tactical employment of a field company under the circumstances described.

Of course it is obvious that it would be impossible to take the tool carts with their teams into the zone of aimed infantry fire. The sappers must be supplied with tools from their pack animals as much as possible, but long before they reach their object the men must carry their tools themselves, and be ready to use either rifle or tool as the need arises. All superfluous accoutrements should be left behind.

In some foreign armies every sapper, as a matter of course, carries a tool of some sort. This is open to objection. The man who carries a saw might be found in a place where no saw could be used. In our army we carry all our tools for the men, but we never practise the rapid advance of men themselves carrying tools and also rifles. It is a matter for consideration whether the sling of the rifle should not be adapted to be strapped to a tool if the need arise. I may also remark that I have never seen any practice worth speaking of at the important work of overcoming and destroying ordinary military obstacles.

In the case of a division being ordered to carry out the attack as

above described, the following would be a probable distribution of the field company. The Officer Commanding would take three sections out of four to work with the main body. The Captain would command the line of tool carts, and endeavour to push them forward as far as he could. The senior Subaltern would command the one section, which would advance with "the chain," carrying such tools as he might consider necessary to establish their position close to the enemy.

On the very rare occasions when something like this manœuvre has been attempted in our mimic peace warfare, the engineers with the main body have conformed to the orders for the infantry of that body, and have been placed under the command of the senior officer of infantry on the spot. It might happen that the senior engineer officer would be himself the responsible commander of the whole party.

This is the brief outline of the work of the engineers in the attack. It must be obvious to every military student that there are other uses of the engineer in the attack, *e.g.*, the strengthening of decisive points, the holding on to ground already won, the covering of a possible retreat, all of which are operations of the greatest importance, and call for the proper use of the engineers. To dilate upon the importance of these operations would be unnecessary. The subject is not studied much in this country, but it is very carefully considered abroad.

One difficulty in practising these operations in peace is the objection to breaking up the ground in trenches. This difficulty is not removed by the make-believe screens, or by throwing up a small sample of the work required. It is a matter for consideration whether certain portions of our manœuvre land should not be allotted as ground where entrenchments may be made, and Commanding Officers made aware of the fact, so that they might arrange their defensive or offensive operations on field days in such a manner as to enable these selected portions to come within the limits of their operations.

One or two examples from the mass of instances in military history are here briefly given.

On the 31st August, 1870, a French division wrested from the Germans the village of Sevigny, near Metz. From want of tools and engineers the French were not able to take advantage of their success. At 10 o'clock the same evening, the Germans, who had held on to a few loopholed houses and yards, were able to make a vigorous counter-attack, and drove the French back.

At the battle of Mars-la-Tour, the Prussians seized early in the day the village of Vionville. Sappers were pushed into it at once. Some of their tool carts were lost by a charge of French cavalry, but they had enough to strengthen the village, so as to form a useful *point d'appui*, and that village was never retaken. It formed the apex of the Prussian position.

At Königgrätz, the Austrian engineers made a number of entrenchments, yet the corps leaders knew nothing about them, nor were

they placed where the attack came. When the Prussians did come to various decisive points, such as the village of Maslowed, Chlum, and Nedelitz, there appear to have been neither the brains to direct, nor the tools to execute, the hasty works which would have made these points of the greatest value.

Königgrätz is an admirable instance of "how not to do it" in the defence.

Plevna, on the 11th and 12th September, 1877, is an equally good instance of "how not to do it" in the attack.

The object of this paper is not to minimize the importance of the combined tactics of infantry, cavalry, and artillery, nor to ignore the very useful *rôle* which is carried out by the engineers in other duties than in combat: but to insist on their importance as a fighting weapon. The object of all branches of the army should be to co-operate together towards success. This may be done by the engineer in sinking wells or building bridges; only, such duties may be classified with those of the Medical Officer, who by skilful sanitary precautions increases the health of the troops, or the Commissariat Officer, who makes good arrangements for their provisions. The duties in camp and communications have always been recognized as part of the engineers' work, but tactical duties have been but little taught, or, at least, very little practised, by our engineers in combination with the other arms in our army. The literature on the subject in English is very meagre.

Napoleon says, "They who neglect the support which the art of the engineer can give in the field gratuitously deprive themselves of a power and an auxiliary, never hurtful, always useful, and often indispensable."

In our small army we cannot afford to disregard this advice.

The CHAIRMAN: As I have had some little experience in peace manœuvres, and as I have seen the growth of field companies, having been at Aldershot with a company of engineers before there was any field equipment supplied to it at all, also having had command of the troop in which all the field equipment for three field companies and a depôt field park was massed together; and, subsequently, having had some experience of the handling of field companies in peace manœuvres, I should like to make one or two remarks. First, I would point out that the great difficulty the engineers suffer from in peace manœuvres in England is a want of reality. They cannot carry out in peace the duties which would be required from field engineers in war. Houses and villages cannot be put into states of defence; nor can trees, bush, and other things which would interfere with the field of fire be cleared, a most important matter, which the lecturer has not referred to specially; for the best way of getting cover from the enemy's fire and protecting yourself, is to bring such an overwhelming fire upon him that he is afraid to shoot at you, or, at all events, fires with very great want of precision. Another matter that I think affects our engineer duties in peace manœuvres is the element of time. There is usually a hurry to bring the troops into collision, and after the troops once get into collision, the battle very rapidly comes to an end; whereas all experience shows, especially in cases where a position has been properly placed in a state of defence, that a long time may elapse before troops are driven out of it. There may be a great deal of fighting, extending over hours, without much advance being made; places are taken and re-taken, and everything is not quite so rapidly finished as in our peace manœuvres. In my own experience, I remember seeing a force at Aldershot with its right resting on a strong position at the top of Beacon Hill,

where houses were supposed to be placed in a state of defence, and entrenchments formed. This force was attacked by another coming from Frensham. To the astonishment of the defending force, who thought their right would hold out some time, the enemy came on rapidly, and in ten minutes the troops were turned out of their strong position. Another case I can remember, where there were troops occupying a position near Hartford Bridge Flats. A company of engineers, with all tools and appliances, was sent down near Blackwater Station with orders to fortify it: they had plenty of time and tools, and miles of telegraph wire. They were ordered to cut down the telegraph posts (of course in imagination), to take the wire and make an entanglement. The enemy's cavalry came on through all the supposed wire entanglements in spite of notices saying, "This is impassable!" "This is stopped, &c.!" The defenders thus lost the advantage they had expected to get from the action of their engineers. Officers commanding mixed forces of other arms, together with this new arm (the engineer field company with all its equipment), have sometimes shown a tendency to use the dismounted part of the engineers, without their tools, as if they were infantry, and to send the carts away, not knowing how they could usefully be employed. This shows that it is necessary, as has been so well pointed out, that officers should carefully consider, when they have this equipment put under their command, how it may be used to the best advantage. With these preliminary remarks I will ask any officers, who have had experience, to give us some useful ideas or information on this subject. If there are any junior officers here who would like to make any remarks, I hope that they will not in any way feel, on account of their being junior in rank, that they are not to make those remarks. Only last night I was told, "It is no use going to the United Service Institution; if I am a junior I dare not speak, I shall be shut up at once." At the Council meetings here reference has been made to such ideas being prevalent, and I have heard the members of the Council say that, on the contrary, they are only too delighted if in any discussion here young officers will fully ventilate their opinions. Some of the opinions expressed may possibly be crude, but others may be very good. I will, therefore, ask you to join us in the discussion.

Major S. Harrison: I should like, although not a junior, to say a few words on this subject. When I say that I have served thirty-one years in the same regiment, perhaps I may come into the list of those who have had some experience, not on the field of battle, but upon those fields where we do the best we can to see what the battle is like. The lecture is peculiarly gratifying to me, because it affords evidence that the condition of mind of the lecturer is the precise condition of mind that I was in some twenty-seven years ago. I am the officer who urged upon the Government at that period, immediately upon the introduction of breech-loading rifles, the absolute necessity of converting the infantry soldier into an engineer. The extreme rapidity of fire made it absolutely necessary, in this country at least, where we should always have to defend, to provide the soldier with the advantage of cover, and in this Institution there lies somewhere a weapon which I submitted to Sir John Fox-Burgoyne, which combines a large number of uses for the infantry soldier. It has the blade for moving the ground; it has the pick for softening the ground, and for loop-holing walls; it has what is a matter of considerable importance, a hole perforated through the spade, behind which the soldier can feel something of safety; for I remember a sergeant-major, who had served in the Chinese War, who said that, when they first went under fire, they really felt that if they could get behind a sheet of brown paper they would have been comforted. Now I respectfully suggest that if it were possible, and you would send for that weapon, wherever it may happen to be,[1] and put it upon the table, you would see at once how extremely gratified I must be to find that that which I wanted twenty-seven years ago, that which I had persistently urged upon every Secretary of State for War at every change of Government, at last has come to the front, and I find an engineer officer of large experience advocating precisely what I advocated, that is, that the infantry soldiers should be furnished with the

[1] During the discussion, the specimen of this implement which was presented to the Museum of the Institution in 1870 was placed upon the table, and, although constructed of the highest polished steel, was found to be in perfect order.—S. H.

means which will make them practically a field company of engineers. In fact the lecturer himself particularly noted that after a time the use of the wagons must cease; the implements must be distributed. The only fault of the engineer field equipment is this, that the number of spades and tools is so extremely limited that, for a country like this, where all sorts of obstacles have to be dealt with by the infantry, at the moment preceding the attack the number is wholly insufficient for the purpose; and I would venture to suggest to the lecturer that he should tell us presently whether, *if it were possible* to combine the various uses of axe, spade, pick, and crowbar in one weapon, it would not be very desirable, for although you might sacrifice some of the perfection and simplicity of the original weapon, it might be of an immense advantage in a country like this, so enclosed by hedges, ditches, and divided into fields and the like, to have a weapon which combines part of the qualities of all these.

Lieut.-General Sir R. Hume, K.C.B: I do not propose to discuss the lecture, because it is so admirable in itself that I entirely agree with all that the lecturer has advanced; but, having been much thrown during my active service and during peace manœuvres also with the engineers, I should not like this opportunity to pass without bearing my testimony to the admirable manner in which we in the infantry especially have always been supported by the engineers, and the manner in which they have taught our men to do necessary work under their guidance. In this matter my experience goes back as far as the Sebastopol trenches, and the admirable manner in which the engineers carried out their own work, and showed us how to do any under their guidance, I have never forgotten. And during the rest of my service, wherever I have been thrown with the engineers, I have found their teaching most admirable; they have not only shown us how to do the things necessary, but most cordially co-operated with us always. I observe that the lecturer alludes especially to the pioneer regiments of the Indian army. I have had a great deal of experience with them, and I entirely agree with all that the lecturer has said in praise of their excellence, both as soldiers, and, I will not say as working engineers exactly, but as pioneers, in which capacity they are altogether admirable. I think the lecturer is entirely correct in what he says as to the manner in which field companies of engineers should be employed; but of course, to carry out works of any extent, they must depend a good deal on the co-operation of the other branches of the army, they being themselves too few in number to be able to execute extended works. I have always thought, and think so still, that the *rôle* of the engineers on active service is to do what they can themselves in the way of entrenchments and works, and, where they cannot do the whole, to instruct as far as possible the bulk of the army, who are sufficiently numerous to carry out the works that they themselves cannot execute. I have always found the Royal Engineers work in every way as an officer thrown with them would wish them to do, and most anxious to carry out any orders that I have ever had to give them.

Colonel E. Wood, C.B.: I might, perhaps, make one or two remarks. I fully agree with what the lecturer has so admirably said, and I would especially draw attention to the point as to the preparation of the ground in front, the clearing of the ground; for that, as has been said, is really after all the most important matter. There is one little point to which I might take exception, but I fancy that is rather a slip of the pen. I fancy that the engineers, when moving across country by themselves, cannot be said to have "nothing to fear from cavalry." Of course they have just as much to fear from cavalry as the infantry have, but, inasmuch as the engineer is a well trained soldier, he has no more to fear from cavalry than the infantry. You may, therefore, trust your engineers to take care of themselves, being assured that they can always render a very good account of themselves if necessity should arise. With regard to carrying the tools, unquestionably it is all-important that any work that you have to do with the tools should be done quickly, otherwise the opportunity for using your tools may have passed. It follows that the stronger and better winded a man is when he comes up to use the tool the better the results will be. I therefore think that our system of carrying the tools on carts as long as possible, and only issuing them to the men when you cannot carry them any farther, is better than the system which obtains in almost every European army, by which the sapper has always to carry a tool.

Lieut.-Colonel C. A. BARKER: I came in here just by accident, but there is one little point that has struck me during the lecture, and which has often forced itself upon my attention during my service, and that is that engineer officers do not always get the co-operation that they deserve from officers of the infantry. I suppose there is hardly an engineer officer who has been much in charge of a working party who has not occasionally had reason to complain of the apathy of the infantry officers in charge with him. I think it is so important that there should be a better feeling and more co-operation between them, and that something ought to be done to remedy it. When a fatigue party is sent to work, whatever may be its size, it is usually placed under the charge of some young officer and thus gets to be looked upon as a disagreeable fatigue. I think that when large working parties are sent out they should have a senior officer with them, and that when a company is sent out all the officers of that company should go with it. In that way the infantry would begin to feel that the duty on which they are sent is really of importance, and so you would get that willing co-operation from them which they would always give if they only knew how important these duties were in the field.

Lieut.-General Sir R. HUME: With reference to what the last officer has said, my experience, which, I am sorry to say, is not of to-day or yesterday, but of some years past, has been quite different from that related by Colonel Barker; but I am evidently not speaking of the same times.

Colonel JONES-VAUGHAN: I should like to repudiate to a certain extent the remarks made with reference to officers of infantry not giving their support to the engineers. I have had some experience of engineer work, both in the field and in peace manœuvres, and I do not consider the remarks made are borne out. I think that infantry officers feel that in an engineer officer and in the engineer corps they have a most important adjunct for field operations, and I think that if in the case referred to, when working parties are sent out, only a subaltern is sent with them instead of the Captain of the company, it is the fault of the regiment, and I hope it is not the experience in every other regiment. I think the general idea is to support the engineers and to do the work that is done as efficiently as possible, and with the greatest support. I quite agree with General Hume's remarks.

The CHAIRMAN: I think that we have got away from the subject, which was "The Tactical Employment of Field Companies of Engineers in combination with the other Arms." I am glad that the remarks that were made by Colonel Barker are not generally agreed with.

Lieut.-Colonel BARKER: I might perhaps qualify them a little in view of what has been said; I simply mean that officers as a rule do not take that personal interest in the work that they ought to do. They very often think that the whole thing is to be done by the engineer officer, and they do not exert themselves to get the men to do their best.

Lieut.-General C. B. EWART, C.B.: I have been waiting, hoping to hear more from the junior officers, and that we seniors should rather come up later on. My own experience may be classed mainly as ancient history. I think we owe a debt to the lecturer for the very interesting *résumé* he has given us as regards the organization and duties of the field companies of engineers, and I wish in anything that I say to hold myself to the subject of the lecture. I entirely concur with what has fallen from Colonel Wood. It is, I am sure, of the greatest importance, if you are getting your men into action and under fire, not to weight them, and not to hurry them if you can possibly help it—to get your tools carried as far as you possibly can, and not to put them into the men's hands till it comes to be absolutely necessary. There is one thing which I think should be very much impressed upon young officers, which is this, that in our Service, and in the various countries in which we have to carry on war where we must carry our own tools, we are very often called upon to take part in operations where it is quite impossible to work with the ordinary wheeled carriages. Going back to the old wars, in 1815 the army of occupation in France was well supplied with the engineer element, and of course they were then equipped so as to always depend upon having made roads to work upon. After 1815 there was a considerable reduction in all arms, and the engineers really were deprived of anything like field equipment practically till 1853. There was no advance; on the contrary, what had been in use was lost. It was

only when we were called upon to take part in the operations at Chobham Camp that we were obliged to cast about and see what we could do to take something of an equipment with us, and we went down with the best that we could turn out from Chatham, which, I am sorry to say, was very poor indeed. The following year we had to go to the Crimea, and then it was lamentable how utterly deficient we were in what we wanted for field service in the engineers. They sent out to us a quantity of artillery wagons from Woolwich, which were to carry our tools, and they did not send us any horses. I went with the Commanding Engineer, and I was acting as Adjutant, and also Brigade-Major (for a short time). I was with him when he urged the want of horses upon Lord Raglan, and begged that he might be allowed even to go and endeavour to purchase them. Unfortunately there was a great scarcity of horses, and we were met by the Commissary-General with the complaint that there was great scarcity of forage. However, before we started for the Crimea we did what we could, and the utmost we were able to organize was that each company of engineers attached to a division should have with it a small mule detachment. We had about six mules fitted with pack saddles, which we prepared in the arsenal at Varna. We did the best we could, and we got all the hints we could from the French who had come from Algeria. We took these with us, but we could not take the field with any wheeled carriages. What we had with us, besides these pack mules, were tools carried in the Crimean Tartar *arabas*. It was only at the end of the war that there came out an organized field company of engineers, who brought with them what we had been longing for all the time. From that time onwards we have not looked back, but the engineer equipment has gone on improving, and now the engineers are able to turn out with troops in the field with a real practical equipment, and that, I, as an old officer, am extremely glad to see. I cannot say how much I think it is of importance that the engineers attached to a division should have with them a proper equipment of tools, and should be able to perform all those duties which have been alluded to, and among the most important of these I certainly would class the repairs of bridges. That was a duty which in the Peninsular War, under the Duke of Wellington, was very much required, and at that time was performed by the old Staff Corps, whose duties have fallen, since the Staff Corps ceased to exist, upon the engineers. But at that time, as we know, and as we can see by looking at the models in the Model Room at Chatham, the Staff Corps had a vast deal to do in this way, and always, I believe, did it well. There are many of those duties which I might allude to, but it is not for me to take up the time of this meeting further than by saying that I fully appreciate the excellence of the lecture which we have heard this afternoon.

Colonel W. Salmond, R.E.: I think the army has reason to be grateful to the lecturer for his lecture. He has shown in very few words and very clearly what the duties of field companies of engineers in the field are. He has also shown by instances quoted from actual warfare, and the Chairman has shown by instances quoted from peace manœuvres, that it is very necessary that the Commander of the portion of the army with which those engineers may happen to be should be fully acquainted with the value of the weapon that he has to handle in the field company. It was through not understanding the use to which the weapon might have been applied that in certain cases which the lecturer instanced Napoleon's disastrous retreat was not minimized as it might have been, and in other ways, by not utilizing this force to the best advantage, opportunities were neglected. Anything that brings out, as this lecture has done, which will now go forth to the army through the medium of the Journal of this Institution, how this force can be utilized for the good of the army, must be of great service to officers who may be in those positions of command where everything will depend on utilizing every arm of the Service that may be under them to the fullest extent. It is only by doing that that success can result, and I hope that that will follow from the better understanding of all those duties which will be brought about by means of this lecture. There is one further point I wish to mention. I have not had very much experience on active service with regard to infantry working parties, but I had a little in Egypt in 1882, and I can only say that neither on that occasion nor in peace manœuvres—of which I have seen a good deal—have I ever at any time failed to find the greatest interest taken by every officer of infantry who might happen to be told off to supervise or

take part in what are called "digging parties," and so far as my experience goes I cannot agree in the smallest way with the officer who spoke as to any want of interest having been shown by infantry officers on such occasions.

Captain SCOTT-MONCRIEFF: With reference to the various remarks that have been made, I beg first to thank you for the very kind way in which you have received my lecture, and for the very complimentary remarks that have been made about it. Major Stuart Harrison was the first officer who urged the necessity of converting the infantry soldier into the engineer. It is extremely gratifying to learn that he is among the audience to-day, but I must say I do not quite agree with him in all his suggestions. I do not think that it would be possible to make an infantry soldier into an engineer under the present conditions of the Service. We certainly may train an infantry soldier, and I have often had that duty entrusted to me, in the elementary branches of field fortification, and I have found, just as Colonel Jones-Vaughan has stated, that there are some regiments who take keen interest in it, and others who do not. I may mention, with regard to this, that the regiment at the summer manœuvres in the Curragh, in 1890, which distinguished itself most in the operations, was one in which the Commanding Officer had insisted upon every Captain and every Subaltern in the battalion going through a course of instruction at the School of Military Engineering. The result was, the whole regiment was very much better than any of the others. Everybody seemed to take keen interest in the work, they carried out the work with hardly any direction on the part of the engineers, and the quantity of the work they turned out was most satisfactory. With regard to another suggestion of Major Harrison's about the combined tool, it is very interesting to see it. I cannot say that I have had much experience with these combined tools, and, for my own part, I am rather shy of them. I do not think the men take very kindly to them, and, after all, we have, to a certain extent, to accommodate ourselves to the likes and dislikes of those whom we command. Colonel Wood has criticized one little point about engineers having nothing to fear from hostile cavalry. I ought to have said that it was not necessary that there should be an escort of infantry to travel with engineer field companies. We are aware that the safety of artillery depends very often upon the escort that travels with it, and for that reason I have found that sometimes in peace manœuvres the Commanding Officer of a mixed force has suggested that an infantry escort should accompany the engineers. That is not necessary. With regard to the system of carrying the tools, of course, it varies. As officers have remarked, the countries where we have to carry out our operations vary so much, that it is almost impossible for us to lay down any hard-and-fast rule as to the way in which the tool should be carried. I merely wished to throw out one suggestion, that was, that in some way or other the sling of the rifle might be adapted for the carrying of the tool if necessary. It might be sometimes necessary for a man to carry this tool and to use his rifle, and, of course, it is very desirable not to burden the men with unnecessary straps. I think it would be possible so to utilize the sling that it might carry some such tool as that which we see on the table. I thank you once more for so kindly receiving this paper.

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There are many ways, as you doubtless know, of "signalling in the field." These are all based upon three necessary conditions—speed, accuracy, and simplicity.

In these express days, "time" is everything, and a campaign which in former times took years, must now be brought to a triumphant conclusion by one side or the other in as many weeks. To accomplish this, it is absolutely necessary that a General should have complete control of his chess board, so to speak, and be in constant and hourly communication with every piece upon it. Prior information and the more speedy transmission of orders may decide the fate of battles. Perfect control, free communication, trustworthy intelligence, and maintenance of carriage and supplies must be received from sources absolutely reliable.

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Captain SCOTT-MONCRIEFF: With reference to the various remarks that have been made, I beg first to thank you for the very kind way in which you have received my lecture, and for the very complimentary remarks that have been made about it. Major Stuart Harrison was the first officer who urged the necessity of converting the infantry soldier into the engineer. It is extremely gratifying to learn that he is among the audience to-day, but I must say I do not quite agree with him in all his suggestions. I do not think that it would be possible to make an infantry soldier into an engineer under the present conditions of the Service. We certainly may train an infantry soldier, and I have often had that duty entrusted to me, in the elementary branches of field fortification, and I have found, just as Colonel Jones-Vaughan has stated, that there are some regiments who take keen interest in it, and others who do not. I may mention, with regard to this, that the regiment at the summer manœuvres in the Curragh, in 1890, which distinguished itself most in the operations, was one in which the Commanding Officer had insisted upon every Captain and every Subaltern in the battalion going through a course of instruction at the School of Military Engineering. The result was, the whole regiment was very much better than any of the others. Everybody seemed to take keen interest in the work, they carried out the work with hardly any direction on the part of the engineers, and the quantity of the work they turned out was most satisfactory. With regard to another suggestion of Major Harrison's about the combined tool, it is very interesting to see it. I cannot say that I have had much experience with these combined tools, and, for my own part, I am rather shy of them. I do not think the men take very kindly to them, and, after all, we have, to a certain extent, to accommodate ourselves to the likes and dislikes of those whom we command. Colonel Wood has criticized one little point about engineers having nothing to fear from hostile cavalry. I ought to have said that it was not necessary that there should be an escort of infantry to travel with engineer field companies. We are aware that the safety of artillery depends very often upon the escort that travels with it, and for that reason I have found that sometimes in peace manœuvres the Commanding Officer of a mixed force has suggested that an infantry escort should accompany the engineers. That is not necessary. With regard to the system of carrying the tools, of course, it varies. As officers have remarked, the countries where we have to carry out our operations vary so much, that it is almost impossible for us to lay down any hard-and-fast rule as to the way in which the tool should be carried. I merely wished to throw out one suggestion, that was, that in some way or other the sling of the rifle might be adapted for the carrying of the tool if necessary. It might be sometimes necessary for a man to carry this tool and to use his rifle, and, of course, it is very desirable not to burden the men with unnecessary straps. I think it would be possible so to utilize the sling that it might carry some such tool as that which we see on the table. I thank you once more for so kindly receiving this paper.

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Of these the electric telegraph is the most reliable, accurate, speedy, and complete. The operators employed are all trained to such a pitch of perfection that the messages received are accepted unquestioned and mistakes very seldom occur.

Its sister, the telephone, can be used on the same wire, and the two communicants can, by its means, come into actual speaking contact, but so far there is considerable prejudice against its use by officers in responsible places; much in the same way as you decline to accept an agreement unless you can "have it in writing," so are they loath to take for gospel what is shouted by one irresponsible clerk at one end of a wire to another some 80 or 90 miles off at the other.

But there are many difficulties in the path of successful telegraphy in the field. Its transport is bulky, it requires carriages, horses, and drivers with their necessary supplies, it requires time to lay down and more time to take up, moreover it is liable to constant interruption and in a hostile country requires guarding more or less along its whole length, as one cut can entirely destroy communication. In Afghanistan these cuts were very frequent, and made by the enemy not so much for interrupting communication as for twisting bits of wire into slugs for use in their matchlocks.

A telegraph line is liable to be not only cut but tapped by an enemy, and important messages may be read by a hostile force or false messages transmitted.

Then, again, it requires a specially trained corps for its use, men who do no other kind of duty; and the numbers so employed are comparatively so small, that an army in the field which depended on the telegraph, and the telegraph only, for its intelligence and communication would be very imperfectly supplied.

Now to pass to No. 3, Mounted Orderlies. This method is the most reliable of the three. A mounted orderly carries a written message of any length, or many such, each signed by the sender, and returns with a receipt signed by the receiver; moreover, it is the oldest and most old-fashioned method, which is greatly in its favour with some people. But, and there are more buts here than to either of the others, a mounted orderly may be killed, or lose his way, or be taken prisoner, and his despatches read by the enemy, and the sender can never be sure that his message has reached until the return of such messenger with receipt or answer. Moreover, if this were the only means of transmission, I fear that the strength of two full cavalry regiments would hardly supply mounted orderlies sufficient for a single day.

Now I go back to No. 2, Visual Signalling. This system is my particular study, and forms the real subject of this lecture. I do not for a moment desire to see it supersede, or to advance the opinion that it is more useful than or superior to, either of the other two; on the contrary, all three have their advantages for the particular times or places in which they are used, and each should assist and supplement the other.

Its advantages are: It requires very little transport, can be used in difficult countries where there are no roads, indeed the more hilly, broken, and inaccessible the country, the better; it has much greater mobility than the telegraph, and presents very few points of attack; it can be used over the heads, so to speak, of an enemy. Changes of station or position can be made at will by the signaller simply walking

or riding a few miles or yards, and with well-trained men it is as accurate and reliable as any signalling system can be. On the other hand, as compared with the electric telegraph, it is slower—as far as I have tried in actual contest, both systems being worked by the best men, about two-thirds slower; that is to say, when we signallers work together at Aldershot it takes three lines of flag or heliograph men, as hard at work as they can go, to clog a military telegraph terminal; we often practise together at Aldershot, and the rivalry between the signallers and the telegraphists is both healthy and amusing. It is more laborious flashing with flags than working the key of a sounder, and reading by eye is much more difficult and fatiguing, and a greater strain on the faculties, than reading by ear. The telegraph once laid can be worked at all times and in all weathers, but a fog or misty weather destroys all chance of receiving a message by visual signal, and unless elevated and suitable spots can be chosen, visual signalling is sadly handicapped, since to send any distance in a flat or enclosed country involves so many transmitting stations that constant work, unless such stations are permanent, becomes almost an impossibility.

There is another system of conveying intelligence in the field which I have not included as one of the three above; I allude to the conventional signs for use in the fighting line as laid down in the drill book. These are very useful in their place, but are possible at such short distances only, and so easily learnt and used by all, that they can hardly be classed as a system by themselves, but rather as an addition to visual signalling.

Principles of Visual Signalling. Instruments and Methods of Using Them.

As these are doubtless well known to most of you, I will only now briefly enumerate the various items.

When visual signalling was first taught at the Chatham School, a code book was employed, and all messages sent by groups of numbers —the same system, in fact, as that employed by ships at sea; but this codeing at one end and uncodeing at the other, with the complicated and numerous auxiliary signs, which referred you to different tables in the code book, wasted much time, and the fact that a slight error of a single figure would often alter the whole context of a message, decided the then Inspector that to spell out each word letter by letter with the Morse alphabet, indeed to imitate the telegraph exactly, was simpler, quicker, and more efficient, and the code book was discarded.

The Morse alphabet has two simple elements, the dot and the dash. These are combined in groups to form the letters of the alphabet, those letters which more frequently occur being the simplest combinations. Take the dot as the unit. The dash is three times the length of the dot. The pause between each sign or letter equals a dash or three units, and between words is double or six units.

Good signalling depends entirely upon these correct lengths or pauses being accurately maintained. Whatever the actual rate of signalling may be, these relative lengths must be kept.

There are various ways of learning and teaching this alphabet. An ordinary novice can easily pick it up in three days. The alphabet once learned, a series of groups of letters are sent with flag, lamp, helio and sounder, at slow rates, until the element of time upon which everything depends is thoroughly grasped. It is absolutely necessary for correct and rapid signalling that letters should be read as a whole, and not by parts. I mean as a note of music is read. To more accurately impress upon the learner the relative lengths of letters we use this sounder; the ear is more sensitive than the eye and less liable to error. These groups are merely the alphabet repeated three times, each representing twenty average words; the letters are written down anyhow, and the object of their use is to prevent all guessing. The various instruments around me are those now in use in our army for signalling. I will not take up your time by lengthy description, but if any of you would like a more detailed explanation of their use and working, I shall be happy to give it after the lecture.

The maximum rate we allow with the small flag or helio is twenty words a minute; but this is excessive and could not be kept up, the physical labour being too great. The ordinary rate is about twelve words a minute with a well-trained signaller. A telegraph clerk averages over thirty words a minute, but it would be a physical impossibility for us to send as fast as that, for, though the ear can keep pace with the sound, the eye could not distinguish the flashes at that rate.

To keep up the supply of trained signallers is one of the perplexities of the much-harassed Commanding Officer of the present day. Bandsmen, servants, orderlies, cooks, regimental transport, mounted infantrymen, sketchers, stretcher bearers, clerks, irritate and annoy him, but the signaller puzzles him more than all. A man made into a good signaller is a sort of Admirable Crichton among soldiers. He must be well educated, well conducted, self-reliant, cool, quick, zealous and not afraid of hard work; not only does he do much extra work by day, but he is taken out night after night for lamp work, when his comrades are out down town. Certainly he may gain a first prize of 2*l.* for his work, but the chances are he won't, for if one man of the team breaks down during the yearly examination, he will be lucky if he gets his 15*s.* Naturally these are the Colonel's best men, and those he would rather have as his non-commissioned officers, but signalling does not lead to promotion. Moreover, his difficulties are much increased when you come to consider that out of a batch of twenty men struck off to form a signalling class, the average number who are likely to prove of any use as efficient signallers is seldom more than three.

The method of yearly examination for prizes is carried out in this way.

The signallers work in pairs. Two messages or groups are sent with large flag by each pair alternately reading and sending. The

Assistant Instructor then sends two groups with small flag, each pair alternately reading and writing down. A complete service message is sent with small flag through a transmitting station. The work with the small flag is repeated in exactly the same manner with the lamp at night. When I tell you that two years in succession the first place has been taken by a regiment whose six signallers have accomplished the whole of this without any one man making a single mistake, and that last year the next ten on the list averaged less than two mistakes, I think you will agree that His Royal Highness the Commander-in-Chief had good grounds for saying that the results were very satisfactory.

I think I can safely say that the first forty-four battalions of infantry examined last year, and more than half of the cavalry and artillery, are as efficient as signallers as men can be. But this is not sufficient; we have trained our signallers, the next thing to do is to train those who use them. Last year all the senior officers went to Hythe for a week's instruction in the use of the new rifle, and it would not be a bad plan to proceed in a similar way by inviting a few of them to stay with me for a week at Aldershot. How would you fare if, having paid your 6*d.* at a Post Office for a telegram, you were to go round the counter and hurry up the operator, or to ply him with questions while at his work, such as, "Has it gone yet? Havn't you finished? How slow you are. Well, what's the answer? Not done yet? Oh, give it me back, I'll send a boy messenger." And yet that is what is constantly done in the field; and, when a man's whole attention is required to be concentrated on the distant wave of a flag or on a flash, to be thus interrupted renders accurate work an impossibility. Again, how can a signaller, perhaps somewhat stout and scant of breath, follow a galloping Staff Officer on foot, and obey an order to send a message with flag to some distant point? Many refuse to hand in written messages, and then complain that what they intended was not properly sent, or mutilated *en route.* No signaller should be allowed to send any message which has not been legibly written and duly signed. Messages should be clear, distinct, and expressed in as few words as possible. It would not be time wasted if the condensing of long-winded orders into short, crisp, intelligible telegrams formed part of a Staff Officer's training.

Signalling should never be used in the fighting line. What can be more ridiculous than to see a fighting line lying down, utilizing every inch of cover, under a supposed deadly fire at 400 yards, all but the gallant and undaunted signaller, who, standing on the highest bit of ground he can find, with his back to the foe, furiously signals, as ordered, for ammunition, bearers, reinforcements, or what not, regardless of the supposed storm of bullets? A General Officer once said to me, when on my yearly tour of inspection, "I've tried your signalling, Sir, and it's all nonsense; it never answers in the field, and I think it's useless." Timidly I enquired how and why; when he explained, not timidly, that, at a recent route marching, he had worked with two battalions marching on parallel lines, and tried lateral communication as he went along. Now, a battalion marches

at the rate, say, of 4 miles an hour, or, say, 110 yards a minute; an ordinary message of forty words would take about ten minutes to code and send, and the halting and calling up of the opposite party and getting to work about ten minutes more; by that time the column would be about 2,200 yards ahead, and by the time the panting foot messenger reached the impatient General at the head of his little column with the answer, I can quite understand that all reason for his message had departed, and also his belief in signalling. But signalling, however useful, where used intelligently, cannot perform impossibilities, and to use it between two battalions on the march in an enclosed country less than a mile apart, when a mounted orderly could do the work in half the time, was not intelligent employment. I could multiply, almost indefinitely, cases where signalling has been supposed to have broken down, but not one where the reason could not be satisfactorily accounted for.

So much for our supposed failures; now let me give you a few instances of what signallers can do, and have done, whilst employed in some of our recent wars.

During the investment of Sherpur, the greater part of the telegraph line between Cabul and Gundamuck was entirely destroyed, but here the heliograph did good service, enabling the Sherpur garrison to hold communication with the solitary post of Luttabund—the connecting link with their supports along the Khyber route—by which means General Roberts was able to assure the army in India, and the Government at hôme, of his security, and to issue important orders regarding reinforcements.

Among the many merits of the heliograph, the ease and certainty of attracting attention must not be overlooked. Every inch of country visible can be gradually searched by its means, and the positions of parties, unknown before, ascertained.

On the 12th January, 1880, Captain Straton, while at the signal station at Ali Boghan, found out that the Momunds had crossed the Cabul river; this intelligence he at once flashed off to Jellalabad, and that night a brigade started off to intercept the enemy. During the following day communication was successfully maintained between General Bright's headquarters at Jellalabad, the brigade sent out, and a detachment of it succeeded in crowning the heights. At 1·15 P.M. (13th) Captain Straton saw about 1,500 men trying to cross the river at such a point that, had they succeeded, the brigade would have been cut off from Jellalabad, and the detachment severed from its main body. But intimation was at once signalled to all concerned, and at 3 P.M. a couple of guns sent from Jellalabad were shelling the enemy with such good effect that they beat a hasty retreat.

General Chapman told me of a signalling incident specially worthy of mention. After the battle of Ahmed Khel he was particularly anxious that the news should be sent to Cabul and so home. Lieutenant Dickie, the Signalling Officer, was sent to the top of the Sheradhan Pass, north of Ghazin, with a squadron of cavalry, to try and find General Ross's brigade, which had been sent out from Cabul to meet Sir Donald Stewart. His supposed line of march was

ascertained from the map and within four minutes after the first flash they found him, and a full report, 207 words in length, was sent 48 miles and so passed on to Cabul, Simla, and London; the two forces did not actually meet for 4 or 5 days after.

A few days later, when encamped in the Arjandeh, collecting supplies, &c., General Chapman sat in his tent sending his orders and receiving supplies from three different valleys entirely by signal.

Mr. Hensman in his book on the Afghan War says (page 36): "Not the least important arrangement of the day was that of signalling. Captain Straton had parties of men with General Baker and Major White, and a third batch of signallers was sent to a high hill to watch the Chardeh Valley and the movements of large bodies of tribesmen who lined the crest of the range overlooking the camp from the west. Heliograms were exchanged between these points and the head-quarters camp, and General Roberts was kept fully informed of all that was happening in these directions. This focussing of all information upon a common centre enabled the General to make his dispositions with accuracy and effect; without the signallers, dangerous delays might have occurred. The heliographing was so thoroughly well done that Sir F. Roberts complimented Captain Straton personally on the success of his arrangements."

Again on page 267 he says: "The signalling branch of the service has come, deservedly, to be looked upon as playing a most important part in every operation undertaken."

In 1880 the besieged garrison of Kandahar opened communication with the advanced guard of the relieving force under Sir F. Roberts at Robat, a distance of 48 miles, and communication was kept up for several hours over the heads of the enemy, who did all they could to stop us, but were powerless to interfere.

The first glimpse of the relieving army was an exciting moment, and when out of the thick hot haze a star-like glimmer suddenly appeared and disappeared, I could hardly adjust our heliograph to answer. They on their side were equally anxious, and Mr. Hensman in his book on the Afghan war graphically describes from their side how we got our first news for nearly a month from the outside world. He says (page 500): "Kandahar was said to lie, in our line of vision, directly beneath this hill. Captain Straton had brought with him some of his mounted signallers, and at half-past eleven a light was directed towards Kandahar. We could not see the city even with our telescopes, as a thick haze hung over the country about it, and for a quarter-of-an-hour no answer was given. The first signal station was on a low hillock to the left of the road, but Captain Straton took another instrument to the slope of a rocky ridge on the right, whence also he could communicate with the main body of our troops halted for the day at Khel-i-Akhund. He had scarcely left the road than (*sic*) Serjeant Anderson, with the first heliograph, saw a faint flash at Kandahar. It was so weak a glimmer that nothing could be made out, but in a few minutes we read a message—'Who are you?' The answer given was—'General Gough and two regiments of

Cavalry,' and then Captain Straton's light was evidently seen by the signallers in Kandahar, who, puzzled by two flashes, asked—'Where are you.'"

Visual signal stations were afterwards established from the signal tower in Kandahar to nine different points at distances varying from 4 miles to 58, and kept open day and night for several months, and during that time only one serious complaint as to an error in any message was made to me.

At the commencement of the Afghan war we crossed the frontier with 20 signallers and 6 instruments for 1st Division; at the end of the war each European regiment had 20 or more trained signallers besides many natives, and between Peshawur and Cabul over 200 men were employed as signallers daily, using 100 heliographs.

Here is one heliogram I have selected which speaks for itself:—

"From General Watson, Shalozan, to Captain Connolly, Piewar Kotal—'Use telegraph as little as you can. The heliograph brings them more correctly. Your telegraph messages go to Kurrum, and have to be repeated on here, hence mistakes.'"

Signalling in Egypt was carried out under difficulties; the country was so flat and unsuitable, the mirage played tricks with the heliograph, and messages had often to be read up in the clouds. During our first occupation of Alexandria two drunken signallers in a distant fort roused Sir E. Hamley and his whole garrison by sending round a bogus message for a lark, a signalling feat which cost them dear.

A curious circumstance deserves a passing reference here; for although it is not actually a signalling story, it is still closely connected with signalling. Some of you may remember that I complimented Sir Garnet, now Lord Wolseley, upon his recent victory, by heliograph from the top of the Pyramids, and assured him that, like Napoleon, forty centuries saluted him. This happened to get into the papers, but somehow they mixed up Alexandria with Cairo and reported that I had heliographed from the Pyramids to the former place, from the nature of the ground a physical impossibility. However, I shortly received a letter from a gentleman signing himself "John Hampden," thanking me for my valuable experiment, which, he added, incontestably proved the truth of his theory that the world was flat and not round, a fact he had been trying to impress upon the Royal Geographical Society for twenty-five years. I was sorry to have to undeceive him, and so, once more, cast doubts upon his pet hobby. The poor gentleman is since dead, leaving that obstinate Society still unconvinced.

Signalling by moonlight with the heliograph has been successfully practised; but the heliograph should be aligned by day. At the time communication was established between the Cabul and Kuram Valleys advantage was taken of a full moon, and a heliograph was set on Kuram from the Agam Pass. The light was seen with the naked eye 12 miles off. I have used it successfully 9 miles.

Heliographs can also be used with artificial lights. During the investment of Sherpur they were worked by night with the reflected

light from lamps between the different faces of the works, and to the pickets on the adjacent heights. The ease and silence of this method, and the correctness of the alignment, are of great advantage. To limited distances the flash from a heliograph is capable of penetrating any ordinary haze, smoke, translucent clouds, or dust. An impromptu heliograph can be made by aligning two sighting points on a distant station, and directing the flash from an ordinary shaving glass on them. Signalling can be carried on by exposing and obscuring the flashes with a book or anything else at hand.

Communicating by signal from Etchowe to Ginghilovo was successfully practised on March 15, 1879, with a sixpenny shaving glass and two sticks to take the alignment, the flash being shut off by means of a board.

Signalling with the Burmah Expedition, 1885–87.

The troops were conveyed from Theyetmyoo to Mandalay, and, later on, from Mandalay to Bhamo, in river steamers, and communication was kept up entirely by visual signalling. The signallers were placed on the roofs of the steamers.

Large flags were mostly used, as the smoke from the steamers and the constant changing of the background, owing to the winding course of the river, rendered the reading of the small flag very difficult.

The steamers halted at sunset for the night, and signalling was carried on between the steamers.

Had it not been for visual signalling the expedition would have been considerably delayed, as there was no other means of communication except by small boats.

For some time after landing, communication was kept up between Ava, Mandalay, and other stations, entirely by signallers, as the telegraph line was continually cut by the enemy.

All service messages were sent by night after the columns had reached their destination, or the General had returned to headquarters.

Many messages of from 50 to 400 words had frequently to be sent after sunset, at long distances, by lamp flashing, there being no other means of communication.

Suakin, 1885.

Extract from report on Signalling, Suakin field force, 1885 :—

"During the campaign signalling has been associated with the telegraph, but, owing to frequent disconnection of the wire, signalling communication has always been kept up along the whole line.

"There were twelve stations connecting the different regimental camps and headquarter camp with each other and with the base on Quarantine Island. Between the 5th and 23rd March a daily average of 64·23 strictly official messages passed through the station on New House, Suakin, and almost as many unofficial.

"19th March. During the cavalry reconnaissance to Hasheen, Lieutenant Morris, 20th Hussars, had cavalry signallers with all the advanced parties, and in direct communication with the General Officer commanding cavalry brigade. The first sight of the enemy was promptly signalled back by flag.

"On the wire being cut, all official messages were sent by signal, and lengthy returns of casualties were successfully sent after dark to headquarters.

"24th March. The telegraph line had been repaired, and cut again by the enemy. On this date the following telegram was sent from the director of telegraphs:—'The General will not have the line kept up as the heliograph is working so well.'

"3rd April. Over 1,200 messages were sent by heliograph including messages to the Queen and War Secretary.

"28th April. Between the 19th and 29th of April there passed through the Handoub signal station a daily average of 118·3 messages; average length 25·46 words.

"In consequence of the frequent interruption in the working of the telegraph owing to damage caused by the enemy, and also by camels and other animals fouling the wire, it was necessary to maintain the chain of visual signalling along the whole line."

South Africa, 1883-85.

Major Davidson says:—"The quickest time in which a message, under ordinary conditions, was received, was one of fifty-two words delivered at Molopolole, thirty-five minutes after it was handed in at Mafeking, a distance of 110 miles.

"The total distance covered by the heliograph since leaving Orange river is 429 miles, which has been performed in six sections, the longest of which has been 110 miles (Mafeking to Molopolole), and the shortest 49 miles (Sitlagoli to Mafeking). The total number of signal stations formed has been 29. The longest distance signalled by heliograph, 42 miles (Molopolole to Kanya, and Mashow to Matuqui), and the longest distance signalled by limelight, 42 miles (Molopolole to Kanya).

"The greatest number of words received and sent in one day was 3,043."

I think these extracts are interesting as showing what we have done; now, in conclusion, let me say a few words as to what I think we can do.

A very distinguished General Officer said to me the other day, "I do believe in your signalling, but only to a limited extent. I mean it should be confined to the line of communications." Now with due respect to so high and experienced an authority, my humble opinion and small experience lead me to an exactly opposite conclusion. I consider that for the line of communication visual signalling should be used only as an alternative or auxiliary to the telegraph, as when the telegraph line for some temporary cause breaks down, or to relieve press of work. An instance of the former case occurred at Suakin in

1885, and of the latter, when the whole of the fresh water canal transport work was controlled by signallers in 1882, of whose efficient work the Naval Officer in charge gave me handsome acknowledgment. But the real work of visual signalling comes in when the telegraph line ends. It is impossible and unfair to gauge its usefulness from examples taken from Aldershot or other peace manœuvres, because these are necessarily hurried. The work of days is often compressed into the hurry scurry of a few hours, and signallers barely have time to take up their necessary positions before the "cease fire" sounds. Brigade Signalling Officers are not sufficiently instructed beforehand or taken into the General's confidence as to the "Plan of Campaign," and much time is wasted trying to find out how to keep touch with the various brigades, so as to be ready for orders. The most difficult duties of signalling are those connected with keeping up communications with units on the move. Let me give you a few instances of how we signallers think we should, and how we shall, be used.

Mounted signallers should be the eyes of the army. All scouting parties should be accompanied by signallers, and reliable information sent back from time to time would be most useful during an advance into an enemy's country. Within an hour headquarters would receive messages from any reasonable distance, say 100 miles, and an army could advance in perfect security. In a small way we practise this in our tactical instruction at Aldershot. A central party of three or four stations is placed in some commanding position A, and a chain of mounted officers sent out in ones and twos several miles ahead. These appear in unexpected places at intervals, call up A, send a message for headquarters, and sitting in my office I receive these messages in quick succession, often from a distance of 12 or 15 miles.

For artillery operations on either flank, connection by signal is invaluable, and at some recent German manœuvres the concentrated fire upon a concerted point by massed batteries 10 miles apart, governed by orders conveyed by signal, was, I am told, the turning point and feature of the day.

For outpost and piquet work, signalling is, in my opinion, absolutely indispensable, and it is almost criminal to neglect its use, especially at night. Look at this plan. Here all the piquets are connected with the supports, and they with the reserves, and back to headquarters. What greater sense of security could be given to a General and the army than the knowledge that half-hourly news is flashed back of everything going on at these watchful points in the extreme front, instead of having to trust to reports gathered by tired Field Officers wearily going their long rounds in the dark, often over almost inaccessible or unknown ground. This is not a fanciful picture of my own; I have purposely taken this illustration from a French signalling book, where it is given as an example of the means which should be employed to receive frequent night reports from piquets. In the many examples I have quoted from recent campaigns, you see how signalling has been usefully employed in the ordinary way, and it would be

presumption in me to suggest more, when its useful limit is only governed by the common sense of those who have to employ us.

There remains one other system, which we sometimes employ. I allude to that borrowed from our friends the Royal Navy, "The Semaphore." This is the alphabet. It is very easily learnt, and far speedier than the ordinary "flag wagging," but can be used for short distances only. It might be used when signalling is absolutely necessary in the fighting line, or to keep touch between battalions, but its real use would be between ships and shore, especially for forts or landing parties. I find the signallers pick it up very easily, and that it in no way interferes or is confused with our regular system.

Most foreign armies have their signallers, but not having had the same opportunities for practice on service, their training is not so fully developed as our own, the Americans perhaps excepted. Since lecturing at Aldershot last year, I have received a letter from Brigadier-General Greely, their Inspector of Signalling (they know how to promote signalling and its chief officer out there), confirming every word I had said, and for which I was taken to task by Colonel Hutton, as to the great importance their army attached to signalling. I think his kind letter to me so interesting and instructive that, with your permission, I will read it.

That, I think, effectually sets the seal upon all I have said as to the merits of visual signalling.

Lieutenant-Colonel W. T. Dooner: I do not know that I have anything very important to say with regard to the interesting lecture to which we have just listened from Colonel Keyser, but there are one or two points I would like to refer to. He has given us many capital examples of when signalling not only can be used, but has been used, on service; but there was one instance which occurred to me in the peace manœuvres during last summer that I would like to refer to, as it is a case which Colonel Keyser has not mentioned. It was in the Isle of Wight, during the mobilization of the troops which took place there. It happened that I was placed in command of some five or six miles of coast line, which I had to defend with my own battalion, some artillery, and also a battalion of militia artillery. I found that by means of the signalling everything worked in the most perfect and thorough manner. I myself was in telegraphic communication with headquarters at Parkhurst; and this example I might mention as showing that perhaps the distinguished General officer to whom Colonel Keyser has referred is wrong. Apparently the authorities do not think that this visual signalling is to be generally used along lines of communication. As they certainly placed me in communication with headquarters by means of the telegraph, I found everything worked excellently; I was enabled to sit in the fort where my headquarters were, and, when I had once settled on the different fighting stations, to move the troops with perfect ease and rapidity by means of the signallers. I had only three stations, my own, one at Sandown Fort, and one at Bembridge, and I found I was able to send the necessary orders to move the troops without the slightest difficulty. The signalling was most useful, and I think that is a case—in defending a coast line—where it must always come in and work well. With regard to the whole question of visual signalling, there is no doubt that General officers used to be a little unreasonable about it. They would sometimes dictate very long messages, and almost before the message could be committed to paper they would be asking the unfortunate signaller had he yet got any answer? And the example given by Colonel Keyser of the General officer who was moving in parallel columns seems to bear out that. That General apparently went to work thoroughly prejudiced against signalling, for he did not

even wait to try and get any reply to his messages; he must have moved on with his column at once, without waiting to get any answer to know if the parallel columns were on the same front with him. Colonel Keyser has referred to the many little perplexities and annoyances that a Commanding Officer has now to put up with. Of course the amount of classes and work, and everything going on in the present day, are a little trying sometimes, but I think you ought to urge on the authorities that they should give some small extra pay to the signallers. Commanding Officers do all they can; they try to treat them in many regiments we know like the band. They permit them, where possible, to have a room by themselves and keep to themselves, which soldiers seem to fancy, for some queer reason—but they do like it; and then for discipline some try to have them under the signalling officer and sergeant. There is no doubt the prizes are a great deal too small, and something ought to be done. It is quite unreasonable in the present day for the State to be expecting General officers—who act in the most liberal manner in their districts—to be giving larger prizes to the signallers. It is quite on a par with the Government a little time ago asking, or trying to induce, the different districts to equip the Volunteers. In my opinion officers are unwise in acting in this manner, and in their liberality are doing what really should be done by the State. Colonel Keyser mentions the promotion question as a difficulty. I do not think that enters very much into it, because if a signaller wants a lance stripe, it is exceedingly easy to give it to him. He can have the first step, and then in most regiments—I know it was so in the regiment I had the honour to command—it generally takes from eight to ten months before a lance-corporal can get any pay. It acts unfairly on the men, lance-corporals not at once getting pay, but such is the system; and therefore this long interval of eight or ten months gives plenty of time to replace the man, so that when he comes first for pay you can then let him go to his duty. I hope Colonel Keyser will impress on the authorities that the signallers should certainly get more encouragement. They work hard; theirs is work that keeps them out of a great deal of amusement. I have gone out in the evening to look at them. There they would be working hard at the lamp signals when there would be scarcely any other men off duty in barracks. This work takes them two or three nights a week to try and keep efficient. I consider that if they give up their evenings they ought to get paid for it, and if the regiment to which they belong comes up to a certain standard, which I will leave the lecturer to settle, I think the men should get some extra pay.

Colonel E. T. H. Hutton, A.D.C.: I am very glad that Colonel Keyser has given me the opportunity of correcting the wrong impression which appears to have been conveyed in America by the report in the "Broad Arrow," of the remarks made by me at the discussion which took place on the occasion of Colonel Keyser's delivering this very lecture at Aldershot, in November, 1891. Brigadier-General Greely is well known in this country for the distinguished position he now holds as Inspector of Signalling in the United States, and for the conspicuous part he played in the War of Secession. I wish, for my part, to say that I am not responsible for the report in the "Broad Arrow," nor for the account the "Broad Arrow" has given of the lecture and of the remarks that I am credited with having made at its conclusion. In common with other students of the Great War in America, I am well aware of the use that was made of visual signalling and of the importance which it was proved to possess. I will read, with your permission, the extract of the discussion referred to, published by the Aldershot Military Society, which correctly gives my remarks: "From the numerous histories we know that, in the War of Secession in America, the telegraph was universally used, and to an extent which perhaps has not been equalled since. Signalling was used, but to a very limited extent (*i.e.*, compared with the telegraph, and considering the vast number of troops engaged), &c." My intention was to show that there were certain objections to any system of visual signalling, due to climatic influences and physical conformation of ground. It was this point which we discussed at Aldershot, with reference especially to a previous lecture on the subject of Field Telegraphs. It is quite obvious to all students of war and to all Generals or Staff Officers responsible for strategical combinations, that the means of communication must be such as *under all circumstances* can be relied on for the con-

veyance of messages to the different bodies of troops concerned. On the face of it, visual signalling, or signalling as explained by Colonel Keyser, in his lecture, is dependent upon certain conditions of climate, and also upon the configuration of ground and country. The remarks I made at Aldershot with regard to the use of signalling during the American war had in view particularly the very difficult character of the country in which many of the operations were conducted. I referred more especially to the battles in the Wilderness, and the battles towards the close of the war round Richmond, which ultimately terminated in the capitulation of General Lee. The country was more or less flat, undulating, and densely wooded, and in such a country signalling cannot be depended upon. Again, signalling must be affected by climatic influences; in storms of wind and rain, in fog and unfavourable conditions of weather, visual signalling cannot be relied upon; it is and must be often useless for the purpose of transmitting messages. Colonel Keyser has stated that the "useful limit of signalling is only governed by the common sense of those who have to employ it." I think that Colonel Keyser is too severe upon Generals and Staff Officers, and that he should modify the "useful limit" and add something with reference to climatic influences and physical condition of ground. Nearly the whole of the instances he has given in his interesting paper have reference to countries where the conditions of weather, as a rule, are favourable, and in such cases it is quite unnecessary, I am sure, to demonstrate the enormous value, and use, that signalling is to an army. It requires really no illustration, because all who have been engaged in recent campaigns, or in peace manœuvres, have had ample opportunity of judging of its enormous value. Many of us at Aldershot were of opinion that Colonel Keyser did not go far enough. We had hoped that he might have shown us how, in combination with the Field Telegraph, he would initiate some inter-regimental, inter-brigade and inter-division system of signalling which would include the use of the telephone and a light field telegraph. It should not be very difficult for the regimental and brigade signallers to acquire some knowledge of the telephone and the ordinary manipulation of a light field telegraph. It seemed to us also a pity that the signalling of the Army should not be in some way connected with the field telegraphs of which it practically is a part. With reference to the tactical use of signalling in the case of outposts, and where detached bodies of troops are concerned, it is almost impossible to overestimate its value, especially at night, where the difficulties of sending either mounted men or men on foot are particularly great. Those of us who have been in recent campaigns, or even in peace manœuvres, have had ample opportunity of seeing its value in these respects over and over again! Therefore any criticism that I have ventured to urge is not intended to in any way detract from the enormous value and importance of signalling generally. We must always bear in mind that the British Army has to serve in all parts of the world, and therefore we must be prepared to make our various military institutions, whatever they may be, suitable to the different conditions under which our varied campaigns will have to be conducted. There is no question whatever, as Colonel Keyser has shown in his paper, and as many of us have had ample opportunities of judging for ourselves, that the importance of signalling is simply incalculable, especially in foreign campaigns, where the climatic advantages are entirely favourable to signalling, and the physical configuration of the ground is also suitable. My remarks are, therefore, intended to imply that our present system of visual signalling might be made more generally applicable to our varied requirements if allied with the telephone and some light portable form of field telegraph.

Lieutenant W. P. C. Lethbridge: Colonel Keyser in his lecture has referred to German signalling. I, for my part, was very anxious to hear whether he intended to make any reference to French signalling. The short time I have studied the French methods in use in their service convinces me that their system claims many advantages over our several apparatus. Roughly described, the apparatus consists of a wooden box 3 ft. by 2 ft., in shape of a photographic camera. There are three sizes in use. The one I refer to is the one generally used in the field. It is actuated by a petroleum lamp. It can come into use by day, as well as by night. It is visible 8 to 10 miles by day, and 20 to 25 by night. In addition, it possesses

a system of auxiliary mirrors which, used in conjunction with the sun, operates in the same way as our heliograph. Thus the instrument combines oil lamp, lime light, and heliograph in one. I refer to this more particularly, as I should like to hear whether there is any intention of doing away with the large flags, which, I think, are the most clumsy way of sending messages that has yet been devised. The labour in using them is excessive compared with the results. I am sure Colonel Keyser will agree with me on that point. He refers in his lecture to a certain signaller being of a very stout nature. I am sure the man referred to had not been in the habit of using a large flag as often as a signaller ought to do. In dull and misty weather flag signalling is most difficult to decipher. In such cases the petroleum lamp has the advantage, and, compared with other lamps, has greater brilliancy for piercing haze or mist. As regards transport, the labour of carrying about our signalling equipment is excessive, and the more we diminish that the better. If we had some apparatus like the French method, to which I have referred, I feel sure it would tend to make signalling more generally used. I shall be very glad to gain some further information on these points from the lecturer.

Captain A. S. Barham: I do not know that I can speak with any authority, or indeed that I ought to trouble you to-day, because I have the misfortune in some respects, and, I may say, the honour in others, to belong to the junior branch of the Service known as the Volunteers. I, therefore, do not enjoy the opportunities of testing the various methods of signalling on active service which have been the lot of other officers. I noted that Colonel Keyser made no reference to an electric signalling lamp. I know there has been one tried. It may be, and probably is, useless, but it would seem to me that at headquarters, at forts, and other places where electric lighting may be established, such a lamp would be of great power and of great service. I have also several times been struck with the fact that mineral oil, so far as I know, has never been tried as an illuminating power, although I may be wrong on this point. The ordinary bullseye lamp with its colza oil is a very smoky and unsatisfactory affair. Mineral oil is used, I believe, in a great many lighthouses, and generally where a great power of light is required. It would be more portable than the lime light, not of course so powerful as that, but it would be in every way a great improvement upon the present lamp. Colonel Keyser mentioned that the telegraph line may be tapped by the enemy, but I have not heard any speaker yet who has referred to the fact that so may the signalling line. I know at peace manœuvres that has frequently been done. We have got into a quiet corner, and have read all the messages the enemy has been sending, without their being a bit the wiser. Of course the remedy for this is to send them all in a code, and if you are going to code your messages some simple code system should, in my opinion, be adopted. Colonel Keyser has told us that it has been tried and has been discarded; but the ABC and other codes are of great value for mercantile telegrams, and I cannot help thinking that some concise and simple code, specially drawn up with a view to its use for military signalling, would be inestimable in saving not merely the time of the message, but also the labour of the signaller, which would be a great advantage. I saw in the "Times" a year or two ago, in an account of the naval manœuvres, a statement as to the happy condition of one signaller who happened to be the only signaller on board his ship. He was fed on beef steaks, champagne, and various other good things, in order to keep him going. It seems a curious way of keeping a man in training, but that appears to have been the one adopted on this occasion. I only mention that to show how valuable a signaller is found to be, and one would think that some means could be devised of sending messages more rapidly and easily than by the wagging of a large flag. We have in the Signalling Manual various illustrations of collapsible drums, of flashing shutters, and things of that kind which, apparently, from the illustrations, do not appear to be of very much use; but it would seem that some adaptation could be made of a shutter, easily portable, which could send messages accurately, quickly, and with infinitely less labour than is required with the flag, especially if a strong wind is blowing. No one has referred to the establishment in this country of a signalling corps. Colonel Keyser, in the letter which he read, showed us that there is one in America. We have a corps for engineering, for army service, and for

almost all other special departments, and why should not the signalling be undertaken by a corps? You would then spare your Commanding Officer the harassing duty of having to tell off many of his best men for signalling, and you would be able to encourage the men more. They would work together, they would have signalling officers who would devote their working time, or the greater part of it, to the perfection of their special branch of the Service, and it would be a great advantage in every way.

Major E. S. COPEMAN: There is one thing that ought to be mentioned in the discussion of a subject like this. The lecturer hardly did justice, in my opinion, to the difficulty of learning the system of signalling now in use. The classes at Wellington Barracks are admirable, they are as well managed as they possibly can be and, with great effort, with every kindness and assistance, they pull a man through in the course of three months. After that, if he happens to be, as I am, a volunteer officer in the country, he goes down to join his regiment, and what chance has he of keeping up to anything like the standard which he attained after three months' hard work at the Wellington Barracks? I think an opinion exists amongst regular signallers that signalling ought not to be attempted by volunteers at all, because they know that without constant practice and experience it cannot be done efficiently; and I believe that, except in some of the crack London regiments, it has not been found possible for volunteer signallers when they have gone to the field to carry out their signalling work as it ought to be done. The fault does not all rest with the officers or with the men, but I think the authorities are partly to blame. In my own brigade we get very little or no assistance whatever from the War Office. The men have not sufficient appliances to carry on their work. No assistance whatever is given, in the way of contribution towards the expenses; we cannot even get the flags that are required for teaching the men their duty, to say nothing of lamps, heliographs, or other appliances. Nevertheless, the War Office has, I believe, signified to the Generals commanding the different volunteer brigades that they are required to provide a body of signallers for their brigades and signalling officers qualified to instruct them. I think if that is required of Brigadiers in the country, it is absolutely essential that such signallers should be thoroughly instructed by a sergeant trained in the Guards or in some line regiment, and who shall have nothing to do but to go round to the different districts and instruct the men so as to keep them up to the mark, in the same way as is done in all the London volunteer regiments where efficient signalling is carried on. If this is not done, signalling in volunteer country brigades will continue to exist only on paper, and when signallers are wanted, I am afraid they will not be found up to their work.

Captain E. HEREPATH: Colonel Keyser has referred in his lecture to the senior officers. He says that last year, senior officers went to Hythe to be instructed in the use of the new rifle, and that it would not be a bad plan to invite a few of them to stop with him for a week at Aldershot. Now, I had the honour of going through a training class under Colonel Keyser two years ago, and I can say that it certainly gave me a great amount of confidence in handling signallers. I have found very good results follow from using it in a small way in summer manœuvres when you have two or three companies in hand. Last year I had three companies engaged in outpost duty, extending very little short of a mile. I was able to place my signallers with the greatest confidence, whereas I am sure that if I had never been through a class I should not have had the same confidence. Further, it had the advantage of leading me to understand the difficulty under which signallers work, and I am sure that if senior officers would adopt Colonel Keyser's advice and stay with him for a week at Aldershot, they would not afterwards be so inclined to call upon signallers to do what they find almost impossible.[1]

[1] I meant to have said the following at the discussion, but it escaped me, as I had not made notes during the lecture: "Although I consider that signallers with outposts are almost indispensable, at the same time they may become a danger if used injudiciously, particularly at night, for an astute enemy sending out reconnoitring parties may find out the general position of the outpost line and view the

A VISITOR: As an old sergeant instructor of a cavalry regiment, I should like to make one or two remarks about instructors in the Indian Service. I was sent up to C——, in the Himalayas, in the monsoon, to take a certificate as Instructor. I arrived there with a large number, most of them knowing very little about signalling. The weather was very misty in the mornings, and by the end of the first month very little had been done except in flag wagging. At the end of three months very little heliographing had been done on account of the weather. When the examination took place, a large number were told that if they would promise to work when they got back to their regiments, certificates would be given to them as instructors. I luckily went up as a trained telegraphist; I knew signalling before I went. We came back, and I had about a dozen signallers who went out with the regiment to do duty, but about half of them knew as much about signalling as that clock. Some of them had their certificates, and were down in the book as trained signallers, but when they came to work nothing could be done. I think that is a most important point that when signallers are sent to obtain certificates they should be well versed in signalling before they go, for two or three months is not nearly sufficient for any man with ordinary ability to thoroughly comprehend what he has undertaken. In the cavalry, a Commanding Officer finds it very difficult to spare men for this duty; with my own men I found them always very willing and only too glad to go out at any time for lamp or other signalling work. They also seemed to evince great interest in the heliograph, but it is utterly impossible for 50 per cent. of the men to learn the heliograph, and to become competent with it, in six months. I always found it was best to teach them from the sounder. After a man has learnt the alphabet, if he has been taught with the sounder, he immediately picks up the heliograph without going through the flags. Though having a fair eyesight, I found it impossible to learn the heliograph until I had been taught telegraphy. In India, a large number of soldiers, especially in the infantry, are employed in the Government Telegraph Offices instead of Eurasians (for which they get extra pay), and would all read the heliograph at the first attempt if required. I found that immediately I was able to read the telegraph, the heliograph came to me as second nature. Directly I saw the flash I could read it, and I think if more attention was paid to the matter of the sounder, you would get more competent signallers.

Major A. GLEN: I am sorry I was not here at the beginning of Colonel Keyser's lecture. I understand he said something in disparagement of Volunteer signallers, or, at all events, suggested that they were not of much use.

Colonel KEYSER: I did not say a word about Volunteer signallers; they were not mentioned.

Major GLEN: I beg pardon; I misunderstood a statement which was made to me just now. I have had some experience with such signallers, and have found it has always been possible at peace manœuvres to do something with them; they have proved of some service, and from time to time, when I have been in charge, I have been told by the officers commanding that useful work has been done by them. This was particularly the case in some Easter manœuvres under Colonel Strachey and Colonel Gascoigne. They both told me that very useful messages had been carried through in the course of the manœuvres by the signallers. There is one remark that I should like to make with regard to signallers in the field. Colonel Hutton referred to the field telegraph; this is rather a hobby of my own,

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position of the supports and reserves by the outposts flashing signals at night without reason or caution. Every signal station should be under the strictest discipline, and no indiscriminate signalling allowed, which in peace manœuvres often happens. It is by no means an unusual thing to our signallers at a station, when tired of waiting for messages, to have a little practice with a flag on their own account, and this should be discountenanced by the officer or non-commissioned officer in charge of the station. It is the object of all outposts to conceal from the enemy their positions, and I consider that if the signalling of different stations is not kept under proper control, this object may not be advanced by signallers."—E. H.

and I suggest the use of a light field telegraph for signallers. My idea of a signaller in the field is that he should be a man who is prepared to get a message through somehow. If the sun is shining brightly, and the distant station is a long way off, by all means take the heliograph; if not, take anything that you can get, even if it is only a branch of a tree, to signal with. There is a way in which signallers in the field may be able to some extent to overcome climatic influences, and that is by the use of a light field telegraph. I do not wish to ride my hobby just now, because the field telegraph is not the immediate subject of this lecture, but as it is connected with signallers and visual signalling, I think it ought not to be left out of sight. Your signallers, whether regimental or forming an independent corps, ought to be furnished with all the best apparatus known for getting messages through under various conditions, and I think that one apparatus that a signalling party ought to have would be some kind of light field telegraph, which can be used with the telephone, and read in a similar manner to the sounder. The Royal Engineers use a comparatively light field telegraph, which will stand a good deal of knocking about. There is a telegraph much lighter than that, which, if laid down, probably would not last very long: a cart passing over it would break it. But as it would only be used in short lengths, it could easily be replaced, and the cost of replacing a mile of wire would not be very much. That is one of the methods by which signallers may overcome adverse climatic influences, and I think that something may be made of it.[1]

Major-General W. L. YONGE: A great deal that I might have said has been already said by speakers who have gone before me, and I will endeavour not to go over the same ground again. I agree with what Colonel Hutton says, that nobody can possibly question the utility of field signalling; nor can any one doubt the extraordinary efficiency to which it has been brought, especially in heliographing, in the British Service. The instances given by Colonel Keyser in his paper, and examples well known to all of us, make it almost superfluous to refer to the subject. But I do not think Colonel Keyser has said enough on the subject of the means by which he arrived at this efficiency. We know that "Rome was not built in a day," and I want to remind you that a signaller is not made under something like three months. The official Manual of Instruction in Signalling, which I have here, says that in about fifteen to twenty days the alphabet may be learnt, the class making in each day five attendances of an hour. Colonel Keyser, in his lecture, says it may be "picked up," whatever that may mean, in three days. Probably the audience, looking at that table of the Morse alphabet, might learn the groups in three days, and perhaps name the different letters, but that is not signalling. You have not only to learn the groups like the notes of music which have been referred to, but you have to transmit them by means of the flag, and others have to read the message so transmitted. The Morse alphabet was originally started in connection with the electric telegraph, and it consists of only two elements, the dot and dash. But there was a good reason in the case of the electric telegraph why only two elements were adopted as the basis of the Morse system. The telegraph needle was not capable, as far as I know, of anything but two motions; these motions were "right" and "left," and therefore if the advocates of the Morse system intend to carry further the system restricted to two elements which obtains in telegraphic instruction, it is excusable for them to accept any apparatus which can furnish the two necessary elements; thus they find all they require in the heliograph and the flag. The heliograph is only capable of these two units, viz., the observation and reappearance of the flash of light called "the dot and dash," and therefore in connecting these two with the electric telegraph

[1] The three-wick and four-wick paraffin lamps commonly used for large magic lanterns, and having no glass chimney, but only a glass plate in front for the light to pass through, have been successfully used (in conjunction with the heliograph, in lieu of a shutter) for signalling at night at a distance of several miles by the Inns of Court Volunteer signallers. The tall iron chimneys were found inconvenient, but might, no doubt, be improved if the lamps were specially made for signalling purposes.—A. G.

it was quite right that the same system of instruction should go on between the heliograph workers and the telegraph operators; especially as I believe it used to be a grievance of signalling officers that as soon as they had an efficient signaller he was seized on by the telegraph department and carried off, and they had to begin again. It was an important part of the duty of instructors in visual signalling to supply the telegraph with operators. The course of signalling takes, according to the official book, forty or fifty working days to learn, but the result is that when Colonel Keyser goes round on inspection and examines the signallers, he tells us that out of, perhaps, twenty, three are the utmost that he can call good and efficient signallers.

Colonel KEYSER: That is not the trained signallers of the army; but when you take twenty recruits to start with, as a rule you will only get about three men of those recruits who will ever become efficient signallers. I am not talking about the signallers themselves.

Major-General YONGE: I am not quite clear as to whom you inspect, whether those sent up as signallers from the corps, or the regimental class of twenty on probation.

Colonel KEYSER: I inspect the regimental signallers.

Major-General YONGE: The six men?

Colonel KEYSER: The six trained men.

Major-General YONGE: That rather strengthens my case; to get these six men the Colonel is obliged to provide something like twenty. In the example of Army Form B, 226, as given in the Manual, there are the names of twenty men, and these men have to go through your course of instruction, occupying from forty to fifty *working* days. That means a good deal more than fifty actual days from the beginning to the end of the course, the men being struck off all duties and parade, and their efficiency is to be maintained by further "frequent practice." It is a pity, having secured these three efficient signallers, that the other seventeen, who have gone through the preliminary training, should be entirely lost to the service, but they are not estimated as signallers. A bad signaller is almost worse than none at all, especially in the case of the dots and dashes, where the loss of a dot or of a dash changes the letter signalled. Therefore, I think, when you speak of the "average" of a regiment, it is altogether misleading: a man should be classed either as a good or a bad signaller; either the one or the other. Take the case of the "Admirable Crichton," referred to as a man who might have earned the 2*l.* prize, but who may be considered lucky if he got the 15*s.* Why does he lose his 2*l.* prize? Not on account of any failing of his own powers of signalling, but simply because somebody else, one man in the team, breaks down, and he forsooth loses the pre-eminence which he might still justly claim, and instead of getting 2*l.* gets 15*s.*, and his battalion is "averaged" out of the 1st, 2nd, and 3rd prizes. The system of averaging regiments, therefore, is altogether fallacious. There should be so many good men and so many indifferent, wherever they are to be found individually. The difficulty is to find a sufficient number to fill up vacancies, and there ought to be some system by which every man could be made a signaller, available under ordinary circumstances. When I first saw this lecture announced on "The Different Systems of Signalling," I thought we should have a description of the various systems, French, German, and others, with all of which Colonel Keyser appears to be familiar;[1] but on seeing him the other day and asking the question, I found it was not so, and that we were to have a lecture pointing out what has been done in our own army. But there are other systems, and, by permission of Colonel Keyser, I will refer to one which is my own invention, and which has been in use upwards of twenty years in the Austrian army. It was described originally in 1871, in the "Proceedings of the Royal Artillery Institution," and copies were in the ordinary way given to the Austrian Staff, at Vienna, who no sooner saw the description of the clock signal vane, than they

[1] I understood Colonel Keyser to say that he had never heard of the so-called Austrian system. "A prophet is not without honour, *save in his own country.*"—W. L. Y.

seized upon it, and, as my informant told me, they said it was a "pearl of price." They set to work at once, and before the week was out made the apparatus themselves, and the system has been in use twenty years. Before that they had the flag system, which they thought so bad comparatively that they threw it over, and still work this system of mine. I have here the Handbook of the Military Forces of Austria-Hungary, which contains a full description of this system. It is not merely a system for the parade ground, but it was the system used during the campaign in Bosnia, in 1878. It has also been spoken very highly of by French and German critics. This system can be learnt in five minutes, and in that space of time I would undertake that this audience should be made perfect masters of it; they could read the signals sent, and could send signals. Having once learnt it, they could never forget it. I know that this is speaking rather strongly, but I have no hesitation in saying that in ten minutes' time the whole of this audience could become perfect signallers. And remember it is not merely a new fad of my own, but it has stood the test of experience. It has been adopted by the Austrians and Swiss, and, I believe, by the Norwegians. After the lecture is over, if any one will care to see the system explained, I have the apparatus here, and, by permission of Colonel Keyser, I will do so. Prince Edward of Saxe Weimar was good enough to help me on one occasion, at Frensham. He gave me three or four detachments of the Guards, and almost before I had done speaking there was a universal cry, "I see it." I took them out the next day with the division, and they signalled successfully, and those who saw it agreed that "there was something in it at any rate."[1] The apparatus could be made very cheaply, and I really think it is worth attention, as a second string to the bow. I do not seek to abolish the present Morse system, which is essential to the heliograph, but I advocate its adoption as a second string to your bow, by which a whole battalion could be made useful in signalling to moderate distances of six or seven miles with the assistance of the telescope. My "clock vane" can do whatever "flag-wagging" can do.[2]

Colonel F. C. Keyser, C.B.: I think, on the whole, my critics have been very kind to me. All that Colonel Dooner said was most complimentary, except that he accuses me of not looking after the regimental signallers. If he only knew, during the four years I have been in office, the efforts I have made for the improvement of signallers, to try and get them paid, to try and get the sergeant instructors in a better position, I am sure he never would have said that. In fact, I have made myself perfectly objectionable over the way in my endeavours to get them extra money and grants. The answer I always receive is, "We spend too much upon signalling already, and we are not prepared to spend another penny. If anything, we shall do the other thing, we shall cut it down." Colonel Hutton, I am pleased to see, is very sociable, too. The only thing I object to is that he accused me of saying that you could *always* signal. I rather think he has overlooked one paragraph, where I said "a fog or misty weather destroys all chance of receiving a message by visual signalling, and, unless elevated and suitable spots can be chosen, visual signalling is sadly handicapped." I do not think he quite heard what I said there. I quite agree that we ought to make the telegraph and visual signalling more interchangeable. I think nearly all our best signallers, with a very little practice, would be very good on the telegraph. In fact, if you ask Captain Lethbridge, he will tell you that his best signallers are often taken away for use in the telegraph offices; and, I may say,

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[1] The Manual says that, "Signalling with flags from the first or attacking line is an absurdity, and should never be attempted." The lecturer has enlarged upon this text, but there is no difficulty in thus signalling in safety with the clock vane, especially if a small code of twelve or twenty-four emergent sentences be prepared for use under such circumstances.—W. L. Y.

[2] After the lecture many of the audience availed themselves of General Yonge's offer to explain his system, and appeared to be quite satisfied that it was extremely easy to learn, and some suggested that it might with advantage be taken up by Volunteers and others, who have no time to devote to the learning of the Morse system.—Editor.

on several occasions, at Suakin and other places, and in India, in my own experience, our best signallers were often taken away by the engineers for their telegraph line, and we had to begin again and educate others for ourselves. Captain Lethbridge wanted to know why I did not say something more about French signalling, and General Yonge also accuses me of neglecting other systems. If once I had begun to speak of the other systems of various nations, as well as fancy notions, I found, from the pile of books I should have had to go through, that it would have made my lecture so long, that I do not think your kind patience would have stood it. I therefore confined myself to what we had at home. I have here the French official signalling book, with a picture of the Appareil Optique, which apparatus is also described. We are told it is very portable: it does not look very portable here. It may be. I never saw one myself, but it is very complicated. Their heliograph, instead of working, as ours does, by hand, with a vertical and tangent screw, goes by clockwork, and if anything had happened to that clockwork in Afghanistan, I wonder where we should have been. Then as to petroleum lamps. In the first place, in India they use nothing but petroleum lamps, but the great difficulty we found in using them was with the glass chimneys. No petroleum lamp will burn without a chimney, and the great difficulty is to get a glass chimney that will not break. If you are signalling you must have a perfectly level piece of ground to put your lamp on; otherwise, put it a little on one side, crack goes your chimney! One drop of rain on the chimney, crack it goes! The signaller in charge carries the flame up a little too high, crack the chimney goes! A gust of wind comes, out it goes, or the chimney cracks again. A petroleum lamp is a very difficult thing to manage, and I found that a whole camel load of chimneys which I got up to Candahar at my own expense was used up in a fortnight. However, we are now trying an "unbreakable" chimney, and the inventor assures me I can throw it in the air, let it fall to the ground, and it will not break. I tried it the other day with great diffidence, and it did *not* break. The great defect or difficulty with a petroleum lamp is that you cannot keep it alight in a gust of wind. Even that colza lamp goes out sometimes. The oil is very difficult to get on service, and it is a nasty black-burning oil. Petroleum would be very much better if we could only get a suitable lamp to burn it. If there is anybody present who can find a suitable lamp there is a fine field open to him. Captain Barham and other Volunteer officers have taken me to task rather about Volunteer signalling. It is not a question to-day of signalling in the various component parts of our Services. I purposely left it out to-day, because the matter is very controversial, and would take too long; so, with their kind permission, I will not say anything about it. We want all to be friends here, and perhaps we should not be if I ventured on detail. However, we will not say anything about that. I consider the Volunteers are improving every year. Last year there were only twelve Volunteer regiments that qualified; this year there are nearly thirty. They have a very good average indeed. Some regiments can qualify, some cannot; those which can do it are quite satisfied with the present state of things, and those who cannot are not. Captain Barham also wanted to know about the electric light. I quite agree with him; what we want is the electric light. It would be a splendid thing. I had an unfortunate inventor who worked at it with me for three years, but we came to the conclusion that to carry two carboys of acid about on a mule's back was a dangerous experiment, and you cannot have primary batteries without acids. If anybody can invent a primary battery that will work by putting a handful of crystals into a jar and pouring a tumbler of water over it, he will make a fortune. Until you can get a *portable* battery, or something of that sort, it is impossible to think of an electric light. I have tried four or five which give a good light, but it is the question of carriage which always spoils them. On service the signaller is only allowed a mule or half a mule, and with that half mule he cannot do much. Then there is the large flag which people have been grumbling about. I quite agree, large flags are a great nuisance; but when you cannot use a small flag you must use a large one. Until you come to the point where we can do away with distance and find something that is better and easier to read than a large flag, we must still go on using it. I am perfectly willing to do away with it as soon as anybody shows me how. Captain Herepath was very kind. I quite agree that some of the senior officers want as much

instruction as some of the junior, and, I think, even more, because to the senior officers it is a new thing. Senior officers very often do not like new things. To many, signalling is comparatively new on the present advanced basis. Before, when we signalled in a small way, it was only done as a sort of freak. Now that we use it constantly as part of our equipment, I think everybody ought to know something about it. One gentleman talked about signalling in India. I can assure him we do things very differently here. I think they carry on the signalling school there on better lines now than they did in his time. No one is allowed to come to my school to begin at all, unless he can send and read at the rate of six words a minute. Major Glen rather took my breath away by accusing me of having said something terrible against the Volunteers. I assure him I never opened my lips about the Volunteers. It was the very last thing I should do to disparage the Volunteers. I have a great deal to do with them. I have attended their meetings very often, and I can only say that it has always been a subject of wonder to me that they could do so much with so little opportunity. All their work is done out of hours, all their work is done at their own expense, all their work is done when the rest of the corps are enjoying themselves; they get nothing but kicks and no ha'pence, and I only wonder that they have any signallers at all. As to a light field telegraph, I think it would be a very useful and good thing between outposts and piquets, and for short distances; but we signallers, when on service, work not by miles but hundreds of miles, and we cover 50 or 60 or 70 miles at a time. No man, and no batch of men, could carry a wire 60 miles long; if they did, it would take too long to lay down, and too long afterwards to take up. A light telegraph such as Major Glen mentions, between piquets and outposts, would be very useful for telephone work and that sort of thing, and could be laid down at the rate of a man running, but for long distance work I do not think it would be very practicable. General Yonge has a baby of his own, and therefore he does not like mine. No mother ever did. But I think, if he would only come down and pay me a visit, we could convince him that, although our alphabet is a little complicated, yet when it is learnt it is thoroughly learnt, and the great advantage we have is that we can work and are in touch with the telegraph. As long as the Morse alphabet is good enough for the telegraph which is used all over the world, I think it is good enough for us. When they change we will change: till then I do not see our way to do it. I will only conclude by thanking you all very much for your kind attention, and also General Sir Robert Hume, for his very great kindness in coming here and presiding as my Chairman.

The Chairman: Ladies and gentlemen, the lecture and the discussion have been so very exhaustive there is not much left for me to say, except that having had personal experience in connection with Colonel Keyser of the value of signalling at Candahar, where he and I were together in 1881, I will just add one instance to those that he has given us of the value of visual signalling. In January, 1881, we had to send a mixed force out from Candahar to Maiwand, a distance of 36 miles. It is a part of the country whose normal state is disturbed. We had to send a force out, because the people would not send in their tribute of grain of different sorts required for the garrison at Candahar. It was quite possible there might have been disturbance more or less, and it was of great importance that the column should be connected with headquarters. On the day the force arrived out there, they established a heliographic station on the top of a hill close to the camp-ground, and that evening the force at Maiwand was connected with headquarters at Candahar. I think that it is pretty good proof of the value of visual signalling. I know it was an immense comfort to me. It is not necessary for me to go through all that has been said already, but I think one of the great points about this lecture is that it has been given to us by an essentially practical man, who is not only an enthusiastic signaller, but who has gone through the ranks of the army, and has commanded a regiment himself, so that he can be in touch with both sides. I am quite certain that in all that he does while working as well as he can for the efficiency of his own branch of the Service, he, as far as possible, respects the feelings and the efficiency of the regiments he has to work with. And, I think, one very great point is that, notwithstanding the many objections that are made to visual signalling, we have been able to have such a

record placed before us to-day, showing what has been accomplished by this means. I do not understand that Colonel Keyser would be at all adverse to having the system improved by electricity or anything else. A fortnight ago we had a most admirable lecture from Mr. Bruce, on signalling by electrical balloons, and I have not the slightest doubt that in a very short time that will bear good fruit. Electricity, of course, is at present in its infancy, but I look forward to seeing it in a very short time applied to our field signalling, and to many other things. With regard to the signalling of the Volunteers, I think certainly in these days the Volunteers and Regulars are so much part and parcel of the same force, that everything that is good for the Regulars is good also for the Volunteers, and what is good for the Volunteers is good for the country. I will not detain you further, but will simply ask you to do what I am perfectly sure you will be glad to do, and that is to join me in a very hearty vote of thanks to Colonel Keyser for his lecture to-day.

OCCASIONAL PAPER.

A SUGGESTION REGARDING TRANSFER TO THE RESERVE.

By Lieutenant E. E. Norris, R.A.

It is, I believe, a generally accepted fact that a great disadvantage under which the English army labours in the training of recruits is, that they dribble in from day to day, and are not received in batches, as occurs in armies which are recruited by conscription. I therefore put forward the following suggestion, which, if carried into effect, would, I think, remove in some degree this great disadvantage; and I also attempt to show how, at any rate in my own regiment, this alteration might be made to work with the greatest benefit for the training of recruits, and also the general efficiency of the corps they join.

To put it very briefly, then, I suggest that the terms of service under which a recruit enlists should be so altered that the eighteenth question put to him on attestation would read in the following way. He would be asked to agree to serve :—

" (*a*.) For the term of twelve years; in army service until the first quarterly day of transfer to the Army Reserve following the completion of seven years' service, and subsequently in the 1st Class of the Army Reserve until the twelve years are completed, or if at the termination of such period of army service you are serving beyond the seas, then for the first eight years in army service, and the remaining four in the 1st Class of the Army Reserve.

" N.B. The quarterly days of transfer to the Army Reserve are February 1, May 1, August 1, and November 1."

(*b*), (*c*), and (*d*) paragraphs of the same question would practically remain the same.

The consequence of this slight modification, it is at once seen, would be that a man who enlists on December 21, 1893, would not be transferred to the Army Reserve, if then serving *at home*, till February 1, 1901; if abroad, his service would not be affected. On February 1 also, all men at home would be transferred who had enlisted between November 1, 1893, and January 31, 1894.

The first benefit of this would be the transfer of men in batches to the reserve, and not as now in ones and twos. I mention February 1, &c., as days of transfer, because January 1, &c., are already very busy times in any regimental or battery office.

I now reach the chief reason for this alteration in the terms of service. Recruits would be received by the service unit from the depôt

regularly once a quarter. At the depôts they would still arrive in driblets, and would there be still put through their first drills as now, but quarterly batches would be sent to the service units, and only at the quarters. To give the fullest effect to this great gain, the following plan might be adopted. On November 1 the Commanding Officer would calculate how many vacancies there would be in his command by the following February 1, including all the men to be transferred on that latter date to the Army Reserve. He would then demand from the depôt that number of recruits. These men would join, say, on November 10, and would be specially trained, and be supernumerary until February 1. On that day they would be absorbed to fill the vacancies created. The demand should always be made slightly in excess of the probable requirements, in order to insure all vacancies being filled up, and also to give the opportunity of putting any specially dull recruit through a second three months' course. I know what a great advantage some such system would be in a battery of artillery, and I should imagine that it would be equally so in a battalion or a regiment of cavalry. Again, in the event of mobilization, these attached men would be ready to hand to fill vacancies created by men found to be unfit for service in the field.

Finally, to bring this system into practical use at once, since it must necessarily be seven years before it could be in full working order, a certain proportion of men might be allowed to go to the reserve about a month before their time. This would only increase the annually required number of recruits by a fraction, and would increase the Army Reserve slightly, and might be carried out in this way. On February 1 all men whose seven years' service expires during February and March would be transferred to the Army Reserve, all men whose seven years' service expired in January having been transferred during that month. To fill the vacancies thus created, a batch of recruits would be absorbed who had been in training since the previous November; and so on through the year.

I put forward this idea in order that perhaps it may in its turn suggest a better idea to the mind of some more experienced officer, and so at last lead to some improvement in the system of receiving recruits in service units serving at home.

FOREIGN SECTION.

THE BUONACCORSI AUTOMOBILE TORPEDO.

(Translated from the "Mittheilungen aus dem Gebiete des Seewesens," by T. J. Haddy, R.N.)

It is tolerably well known, through various notices which have appeared principally in the daily papers, that a new fish torpedo has been constructed by Count Adolf von Buonaccorsi di Pistoja, and we must fulfil the wishes of many of our readers who take an interest in torpedo matters if we here enter into a description of the above torpedo as compiled from five letters patent and two printed pamphlets which have been laid before us. As can be perceived from the whole tenour of the following description, we confine ourselves strictly to the employment of the above printed notices without giving any opinion whatever on the torpedo itself, its mechanism, or the qualities ascribed to it, &c. The Buonaccorsi torpedo is propelled by the reaction due to the efflux of compressed air from the blades of the propellers. This invention, as well as the special mechanism for controlling the depth, sinking the torpedo at the end of its run, exploding the charge, and also the charging and supply valves, are subjects of the letters patent above mentioned. Trials with the Buonaccorsi torpedo were carried out, to our knowledge, in 1890, at the Imperial launching station in Kiel, and further in Nussdorf, near Vienna; the results, however, have not yet been published. The fact that the "Vulcan" Company, in Stettin, has acquired the patent in Germany for this torpedo, and has established a range with a view of carrying out extensive experiments with it, proves at any rate that with them the invention is considered of the highest importance. Buonaccorsi endeavours in his torpedo to overcome the defects which, in spite of all improvements, and the great perfection of the present type, still remain in the Whitehead torpedo, viz., (1) complexity, as a result of which constant accidents occur in the propelling, balancing, and depth-controlling mechanism; (2) limited range, by means of holding a high velocity of the torpedo in reserve. In external form the Buonaccorsi is exactly similar to the Whitehead, with pistol, charge, depth-regulator, air reservoir, rudders, and twin screws. (Fig. 1.)

Fig. 1.

The following description of the internal mechanism, as already mentioned, is exclusively from the letters patent:—Propelling

Fig. 3. Fig. 4.

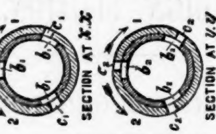
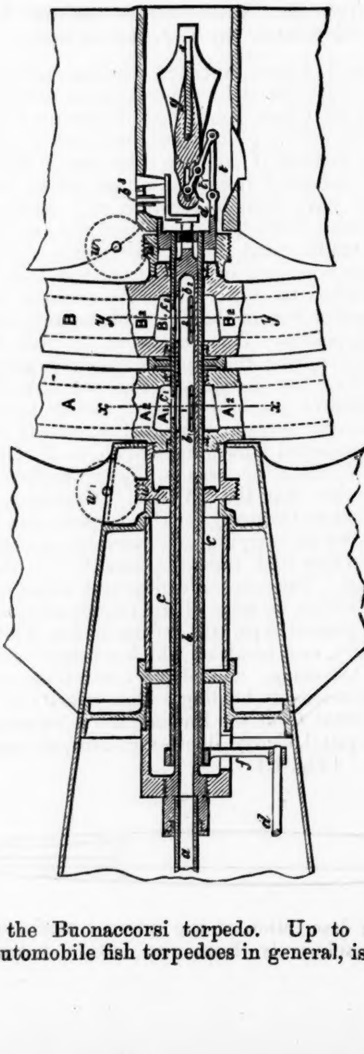


Fig. 2.



mechanism of the Buonaccorsi torpedo. Up to the present the propulsion of automobile fish torpedoes in general, is obtained by the

action of compressed air on the piston in an engine cylinder, producing the rotation of the propeller shafts, and by means of gearing the revolution of two propellers in opposite directions. This kind of propulsion is subject to the following losses of power:—The air pressure during admission to the cylinder, and also on exhaust after having performed its work there, has to overcome considerable resistance during its passage, and the friction of machinery and the continual change of direction in motion of the pistons and slides of the engine cause continual loss of power. The necessity of a regulator to maintain a constant pressure, and speed of engine and torpedo during the period of its run, also causes a waste of power, and finally the wheel gearing employed to obtain the rotation of the propellers in contrary directions also requires an expenditure of power. By all these conditions the scope of the motive agent is decidedly contracted, and the obtainable speed of the whole mechanism brought into narrow limits. The system of propulsion of Count Buonaccorsi permits that the cylinder-engine, pressure regulator, and wheel gearing may be dispensed with, with the possibility of simplifying the mechanism of the torpedo considerably, and also increasing the useful work obtained from the compressed air. The principle of this system consists in developing the energy, by applying the reactive force of compressed air, allowing it to escape freely, immediately to the propellers and causing them to revolve, instead of employing the statical pressure of the air on a piston when confined in the cylinder of an engine.

Of the annexed figures, Fig. 2 shows a longitudinal section of the after part of the torpedo with both propellers, Fig. 3 and Fig. 4 sections through x—x and y—y of Fig. 2. The air, which is compressed to 70 or 90 atmos. into a cylindrical reservoir slightly smaller in diameter at both ends, is led out of the reservoir through a fixed tube, a, which is connected by an air-tight connection with another tube, b, the latter capable of revolution on its axis, and enclosed by the tube c; on these tubes the propellers A and B are fitted, of which A is a right-handed, and B a left-handed screw. The boss of each of these propellers contains a conical chamber A′ and B′, which surrounds the tube c, and into which the compressed air has access through the tubular shafts b and c, and the slits b', c', and b^2, c^2, which are cut through them. The air is led out of these chambers (which form a sort of pressure reservoir, and by means of which, in conjunction with the propellers, which act as governors, the speed of the torpedo can be regulated) through the channels A^2, A^2, B^2, B^2 formed in the blades of the propellers, to the surrounding atmosphere or water, as the case may be; and the rotation of the propellers in the opposite direction to the issuing air is thus obtained by the force of reaction. The speed of revolution of the two propellers is regulated by the size of the openings through which the compressed air is admitted to the chambers A and B, and the speed of the propellers may be quite different, as by this means the unequal effect of the propellers, which up to now has had to be counteracted by means of rudders, &c., is

obliterated, and the adjustment of the torpedo effected; the inventor has found by experience that, with the increase or decrease of the speed of propeller, its directive effect on the torpedo increases or decreases, and consequently it is only necessary to make the difference in speed of the propellers of such a magnitude as to exactly balance each other in directive effect on the torpedo.

Again, as before mentioned, the speed of the propellers depends on the size of the openings through the two tubes b and c, through which the air pressure is admitted to the chambers A′ and B′; it follows therefore that by changing the size of these openings, changes in the revolutions of the propellers, independently of each other, may be obtained, and consequently a resultant steering effect on the torpedo. The variations in the size of these air supply orifices is obtained in the following manner:—The inner air tube b, Fig. 2, side view and section, is provided with the longitudinal slits b^1 and b^2, Figs. 3 and 4, in section, in the wake of the propellers, and these openings communicate with similar openings of half the width in the outer tube, c, and it can be so arranged that the compressed air may be admitted to the chambers A and B, through the full area of the openings c^1 and c^2, or these areas can be reduced by altering the relative positions of the inner and outer passages. The two openings c^1 and c^2 can never come at the same time in coincidence with their corresponding openings b^1 and b^2 in tube b, and it is by revolving the pointer b^3 fixed to the tube b, in direction of the arrow 1 (Figs. 3 and 4), that it is possible to throttle the air admitted to propeller A; or *vice versâ*, by moving the pointer b^3 in direction of arrow 2.

For registering the number of revolutions of the propellers throughout the run, the two worm wheels w, and the toothed wheels w' (Fig. 2) are fitted. In this after part of the torpedo there is also a part of the depth-steering apparatus, viz., Fig. 2, the diving rod d worked by the steering engine, and connected rigidly to the tube c by the arm f, so that, as the latter tube is movable in an axial direction to the tube b, the movement of the arm d can be transmitted without change to the rod d', in the after end of the tube c. This rod d', by means of the connecting rod and lever, t, t, is connected to the horizontal rudders and communicates to them directly the movements of the diving rod. The most important novelties claimed by the inventor in his patent are: (1) the propulsion by means of the reaction of compressed air on the propeller blades; (2) the means of governing the direction of the torpedo by variation of speed of the propellers through varying the supply of air pressure to the same; (3) the mode of transmitting the movement of the depth regulator to the horizontal rudder arms by means of the hollow movable propeller shafts.

With regard to the construction and dimensions of the new propelling apparatus, the following calculated results are taken from an article by the inventor. The air is compressed to 80 atmos. into a reservoir of a capacity of about 0·12 cub. m. = $4\frac{1}{4}$ cub. ft. This air flows through a straight tube of the same effective area as the outlet orifice in the reservoir by the shortest course to the hollow tubes of

the propeller shafts. On these shafts, in the usual position, not keyed on but movable on their shafts, are the two-bladed propellers of 0·32 m. diameter (12⅝ in.). The boss of each propeller contains the conical air chamber already described, and each is fitted air-tight, both at its forward and after sides. The air pressure passes out from the before-mentioned conical chambers by four channels of rectangular section, 30 mm. by 1 mm. in width, into an outlet opening of 0·00003 sq. m. in area, bored through each of the propeller blades, leading out to the point of the blade. The radius of curvature of these channels is constant, and equal to 0·1 m. The angle at which the concave surface of the channel is met by the issuing air is 10°, the bend of the channel is 90°, the whole length of the surface acted on by the pressure in each channel is therefore 0·15 m. By the calculation of the inventor, his propelling mechanism, with an initial pressure in reservoir of 80 atmos., and using up all the energy of the air to the final pressure of 20 atmos., obtains a useful effect of 109e(= H.P.), which gives the torpedo a velocity of 34 knots, or in two minutes it would cover a distance of 2,000 m. The charging and air-supply valves of the Buonaccorsi torpedo have, in the view of the inventor, particular advantages: whilst in the other fish torpedoes worked by compressed air the air supply valve is a lift valve, in the Buonaccorsi a cock is used, and the plug is held in position by a flat spring, which bears against a square on the plug both in the "open" and "closed" positions. The key which opens and shuts this cock is connected to one arm of a three-armed lever, the other arm of which projects through the shell of the torpedo, and serves to open the cock in the same way as the air lever of the Whitehead torpedo, that is, by means of the tripper of the launching tube. The automatic closing of the starting valve is obtained by the action of the propelling mechanism on wheel work which releases a spring which has been put into compression on opening the starting valve, and which is connected by means of a link to the third arm of the lever on the plug of air cock. The charging pipe is fitted directly on the after end of the air reservoir, immediately in front of the air supply valve and connected to the same pipe, the valve itself being fitted on the upper end of the charging pipe, so that when it is compressed by the charging nozzle a direct communication is opened up to the air reservoir. The depth-controlling apparatus is on the same principle as in the Whitehead torpedo, a combination of a hydrostatic valve and spiral spring and heavy pendulum, the spring adjustable to the pressure corresponding to the required depth of the torpedo during its run. This apparatus is placed immediately in rear of the explosive chamber, and the action is communicated to a servo-motor by a rod passing through a tube through the air reservoir. There is also an arrangement for fixing the horizontal rudders in any desired position for a certain time, and for bringing the rudders up when the torpedo is stopped, and so bringing it to the surface. A sinking valve can also be opened at the same time, if desired, to sink the torpedo by admitting water to the after chamber. The safety pistol, to prevent a premature explosion of the charge, is

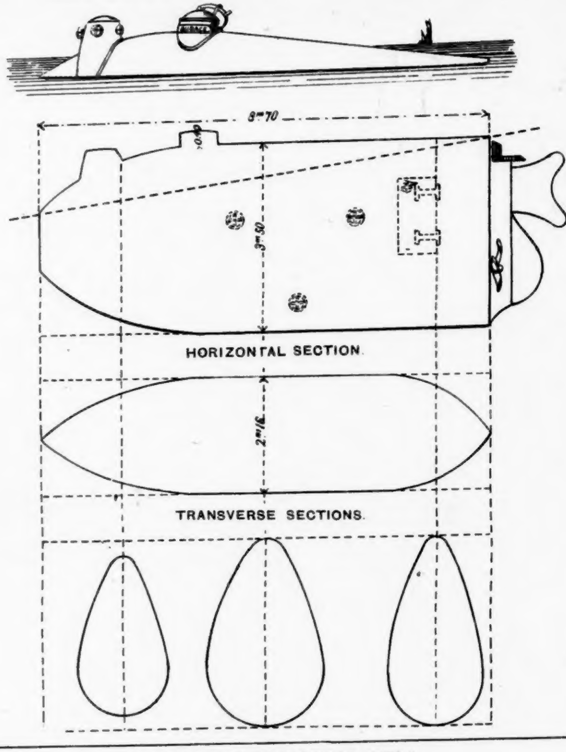
of the "fan" pattern. The material of which the torpedo is constructed is, with the exception of the steel air chamber, Austrian delta metal.

From a pamphlet by the inventor, it appears that it is proposed to make the air chamber also of delta metal, the experiments on a shortened air vessel of this metal having shown that there would be no technical difficulty. The inventor claims for his "reaction" torpedo, as against the automobile fish torpedo: 1, increased speed; 2, increased range; 3, greater reliability in direction; 4, simpler mechanism; 5, more perfect action of the steering apparatus; 6, increased range of depth, as well as a simpler and more certain adjustment of the same; 7, larger range of action of the explosive; 8, more exact adjustment of the controlling gear of horizontal rudders; 9, more reliable action of the stopping and sinking gear.

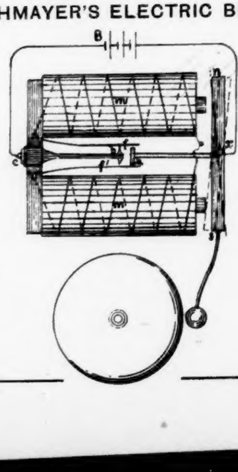
Further, the fish torpedoes of former types may with comparatively small expense be easily converted into the Buonaccorsi type, as the explosive chamber, air chamber, buoyancy and balance chambers, &c., are not interfered with to any great extent by the new fittings, and a good many of the internal parts also may be utilized in the conversion.

SUBMARINE BOAT "AUDACE."

ELEVATION ABOVE WATER AND LONGITUDINAL SECTION.



BOHMAYER'S ELECTRIC BELL.



HARRISON & SONS, LITH. ST MARTINS LANE, W.C.

BOHMAYER'S ELECTRIC BELL.

Translated from the "Mittheilungen aus dem Gebiete des Seewesens," by T. J. Haddy, R.N.

In the hall for telephonic and telegraphic apparatus at the Frankfort Exhibition, among other exhibits, Bohmayer's electric bell is especially worthy of notice. It is suitable for use either in the house or on board ship, and with the current from the electric battery or dynamo machine, either constant or alternating, and its action cannot be affected by residual magnetism, from which it is entirely free.

The actual arrangement of the instrument is shown in the attached figure. The polarized armature *ns* is movable about its axis *x*, and carries a metal arm with contact piece, *a*, fixed vertically to its longitudinal axis ; according to the position of the armature, the contact piece *a* is in contact with one of the springs *f* or *f'*, which are insulated from each other, and from their supports. A second fixed metal arm, *cb*, is insulated from the springs, and carries the contact piece *b*, against which one of the springs *f* or *f'* bears, viz., that which is not lifted from it by the movable arm *a*, so that one of the springs is in contact with *a*, and the other with *b*, and these contacts are reversed by the oscillating movement of the armature *ns*.

The ends of the magnet coils *m* are connected to the springs *f* and *f'*, and the current (for example, from the battery B) is led to the points *x* and *c*, and the contacts *a* and *b*. If the armature is at rest, one of the springs will rest, say, *f* on *a*, the other on *b*, and, if the circuit is now closed, the armature receives an impulse which puts it in such a position that the spring *f'* now lies on *a*, and *f* on *b*, the current in the magnet coil is reversed, and the armature receives an impulse in the opposite direction, and so on as long as the current is kept closed, and the bell is kept ringing by the rapid and continual reversion of the polarity.

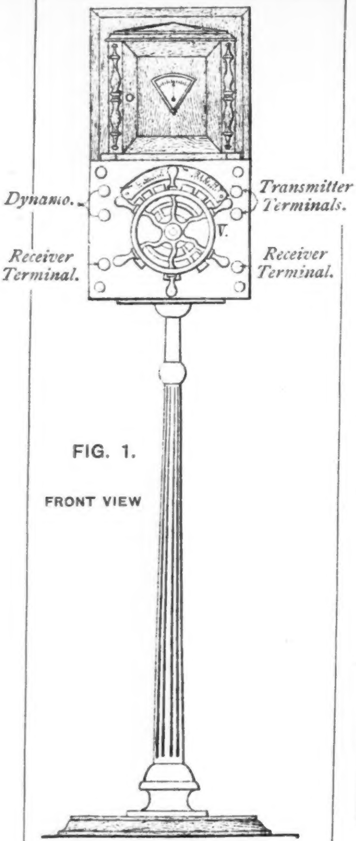
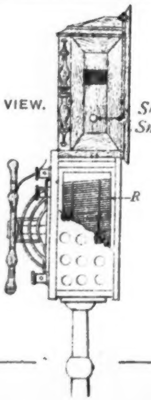


FIG. 1.

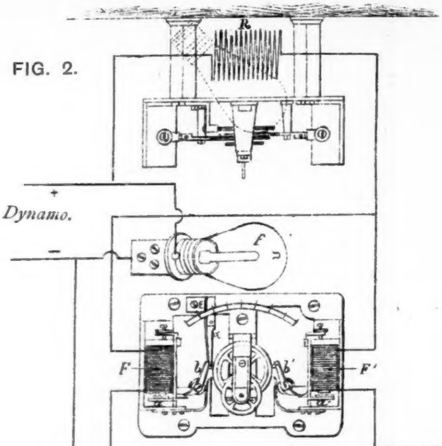
FRONT VIEW

SIDE VIEW.



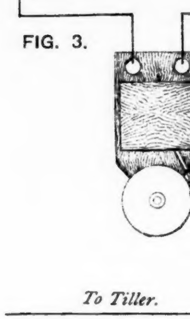
INDICATOR, LAMP, AND PLAN OF CIRCUIT.

FIG. 2.

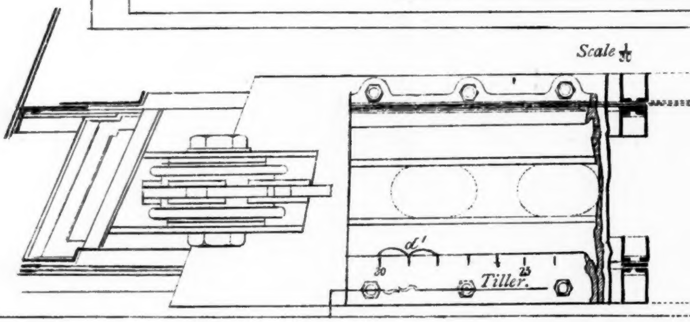


ELECTRIC CEL

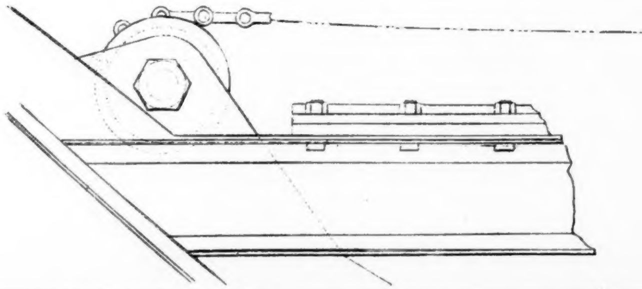
FIG. 3.



Scale $\frac{1}{30}$



FRONT VIEW.



C CELL AND PLAN OF CIRCUIT.

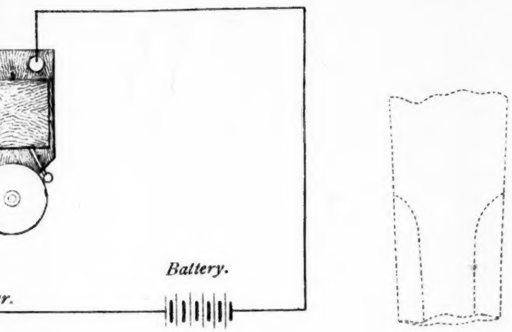


FIG. 6.

PLAN OF CIRCUIT.

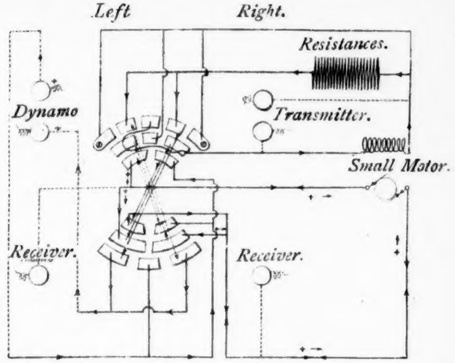
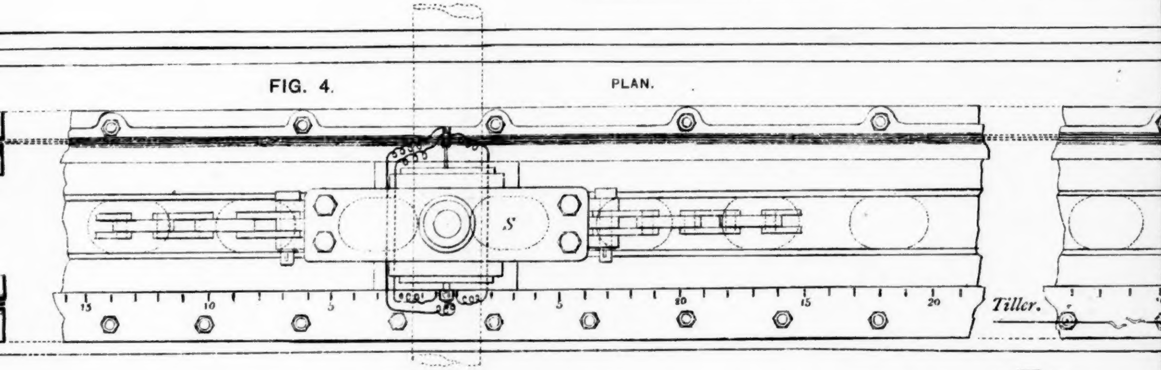
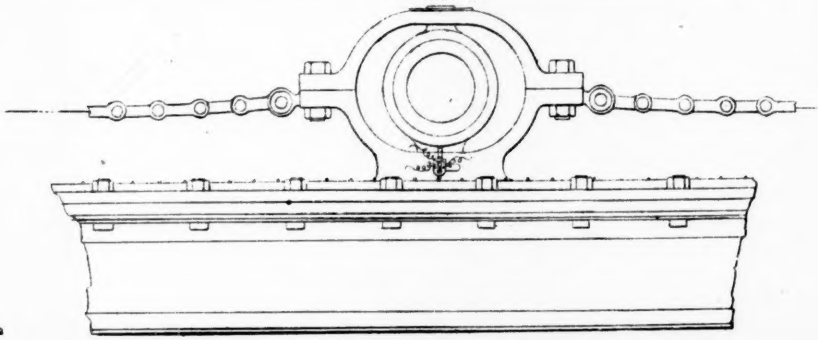


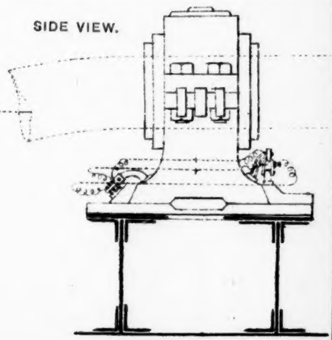
FIG. 4.

PLAN.





SIDE VIEW.



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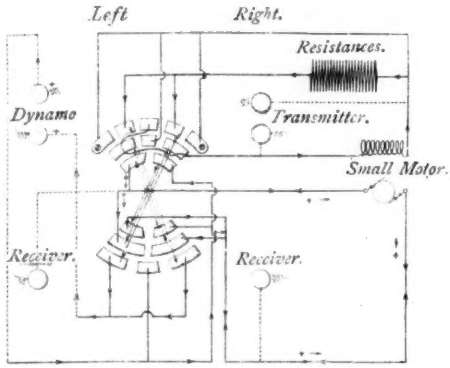
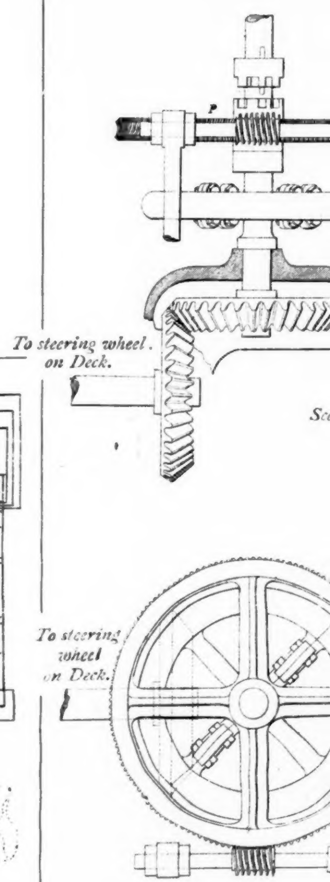
L TRANSMISSION AND INDICATORS FOR THE MOVEMENTS OF THE TILLER.

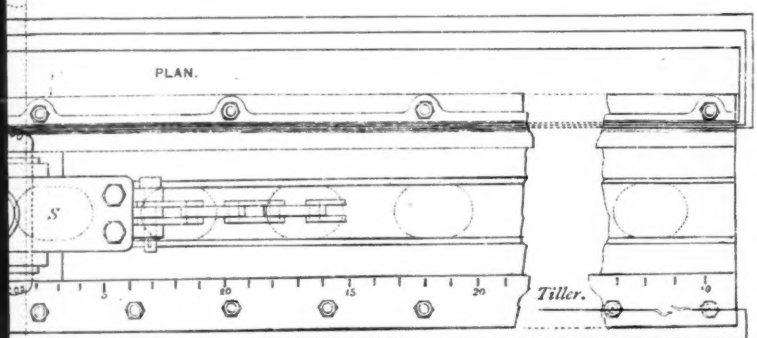
FIG. 6.

PLAN OF CIRCUIT.





PLAN.



SIDE VIEW.

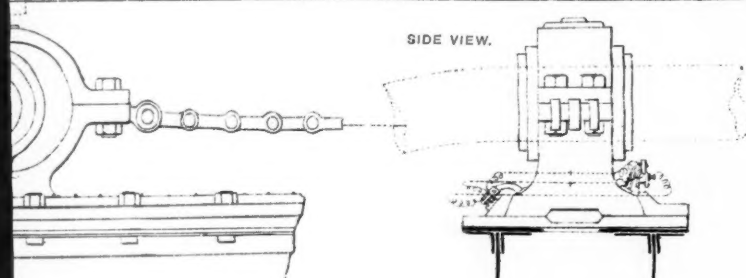


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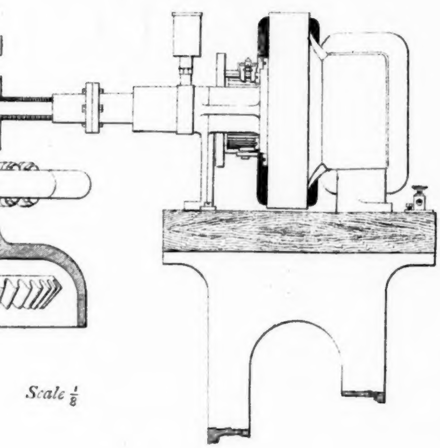
FIG. 5.

ELECTRIC MOTOR.



Scale $\frac{1}{8}$

PLAN.

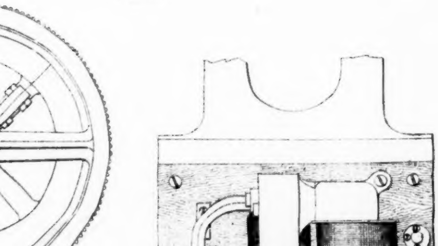
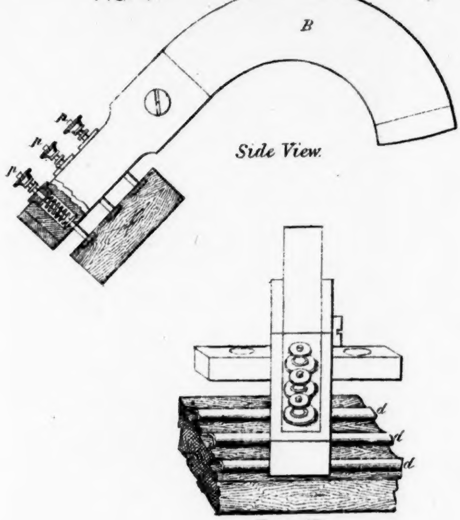


FIG. 7.



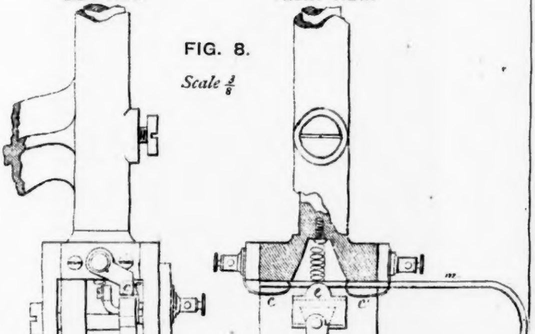
Front View.

CONTACT MAKER X.

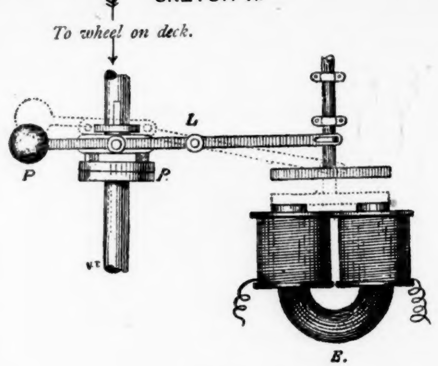
SIDE VIEW. FRONT VIEW.

FIG. 8.

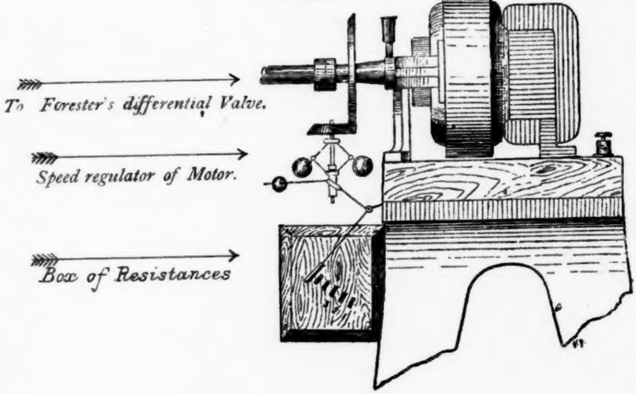
Scale $\frac{3}{8}$



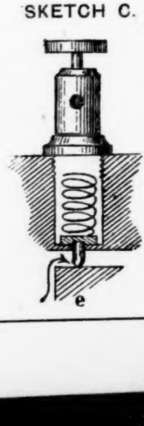
SKETCH A.



SKETCH B.



SKETCH C.



ELECTRICAL TRANSMISSION AND INDICATORS FOR THE MOVEMENTS OF THE TILLER.

By Vittorio Moreno.

(Translated from the "Rivista Marittima" for September, 1892, by T. J. Haddy, R.N.)

The large amount of gearing on board ships for the transmission of movement to the various steam or hydraulic engines for steering purposes is sometimes, under ordinary circumstances, the cause of so much inconvenience that it is necessary to have recourse to steering by hand. In action, the effect of projectiles, especially shells filled with high explosives, might easily interrupt the transmission to the engines of the steering gear, and in a large ship which could not well be steered by hand, in such conditions her safety would be compromised. It will not appear inopportune, therefore, to have brought out an auxiliary system at small cost, which assures the good action of the tiller. The first study of this question was made in the year 1887 on the Royal naval ship "Italia," on which the first experiments were also carried out with the happiest results. A second trial was made in the "Lepanto," and the annexed drawings represent the electric transmission and indicator, also electric, used on board that ship. A small electric motor (Fig. 5) transmits movement to an endless screw which gears into a toothed wheel fixed on a spindle, which, by means of two bevel wheels, gives the same movement to the "Forester's" differential valve. The upper part of the spindle, which is connected to the steering wheel on deck, rests geared automatically at *p* (sketch A). With the passage of the current in the two coils, the magnet E attracts the lever L, which then occupies the position shown in dotted lines, and disconnects in this way the upper spindle. When the current ceases, the counterbalance weight P causes the lever L to resume its original position, and puts the upper spindle again in gear. This arrangement is absolutely necessary, because if the ordinary means of transmission fail, the electric transmission must be ready to act at once, without any loss of time whatever, for in certain circumstances a single instant of delay might prove fatal.

According as the small motor revolves in one direction or the other, the movement of the rudder is to right or left, and nothing is changed in the ordinary fittings for transmission. The small motor employed is by Siemens and Halske. It takes a current of 8 ampères with a tension of 60 volts at the machine terminals, and is furnished with carbon brushes. In working the rudder at "easy" and at "full" speed, there is not a trace of sparking at the first, and very little at the second, rate of speed. "Easy speed" is quite sufficient for a good

control of the steering gear. As the resistance to be overcome for opening the valve is not above 20 kilos., it is sufficient to employ a motor with an armature of less diameter than the one actually used, and, with a motor of smaller power, the velocity of the tiller could be maintained by decreasing the diameter of the tangent wheel which opens the valve. In order to regulate the velocity of the motor, the regulator represented in the accompanying explanatory sketch (B) is used, an examination of which will give a sufficiently clear idea of its action. In order to obtain the communication from the generating dynamo of the current for the motor with the motor, an "Invertor" is used, of the form shown in Fig. 1, the plan of the circuit of which is shown in Fig. 6. Breaking contact by means of the wheel V (which could be replaced by a simple handle), the motor is stopped instantly, in virtue of a counter-current which acts on the magnets of the motor itself. The arrangement represented in Fig. 6, intended also to obtain such an immediate arrest of the motion, was necessary, otherwise, with such a high velocity of motor, the tiller would continue to move some degrees more or less than required.

When the tiller arrives at the end of its course, or, better, some instants earlier, corresponding to an interval of two degrees, an electric bell is put in action, which gives warning to the helmsman that the tiller is "hard over." In manœuvring in this manner, the need was felt of an electric indicator which would faithfully reproduce the movement of the tiller. This indicator is shown in Fig. 2.

To the slider, S (Fig. 4), a small apparatus, X (Fig. 8), is applied, which, in travelling with it, strikes against the teeth d', in the plane on which the tiller head travels, with the extremity d of the sliding contact (n), and, as soon as a tooth has passed, the contact (n) will regain its former position by means of the spring (m), and, having in the meantime displaced the small pendulum (o), will make contact with C or C′ at its upper end, according as the tiller is travelling to the right or to the left. This upper extremity (e) is in connection with terminals by means of a spring contact, as in sketch C, which maintains contact without impeding the movement. The extremity (e) represents the common negative pole, while the two small springs, C, C′, represent the two positive poles of the indicator circuit, of which I will give a short description. It consists of four coils, two for the right hand movement and two for the left. It can be used with the circuit from a battery, or from the dynamo itself; there is, however, a resistance of 305 ohms in wire of a diameter of 0·40 mm., which occupies very little volume. The wire of the coils is 0·25 mm., the resistance in ohms for each pair of coils is 45. In using the pile battery system, it is necessary to furnish them in two separate boxes, so that for one direction of the tiller the battery of one side is brought into action, and in returning the tiller the other is in action; this is with the object of giving them as much repose as possible, to prevent polarization. In working the tiller, the small fitting, X, makes contact with C or C′, as above described, in passing each tooth of the toothed rack underneath, and the poles C, C′, are in connection with the coils of the indicator shown in Fig. 2. By means of this arrange-

ment, the small armatures a, a', are attracted, and, working the levers b, b', the quadrant of the indicator is moved one tooth for every tooth passed over by the tiller, and in corresponding direction, which is shown on the index of the indicator. The quadrant of the indicator is prevented from moving more than one tooth by means of a catch.

The velocity of the wheel of the indicator is six seconds to complete one revolution, a velocity amply sufficient, however precipitated the motion of the tiller may be. We shall have, therefore, ensured the precision of the indications, as the contact maker X does not break contact until it has passed over the tooth and escaped on the other side, thus remaining sufficiently long in contact. This is an important condition to ensure correct indications, and if the tiller should be stopped or moved in either direction the movements are faithfully reproduced at the indicator, degree by degree. A small lamp, Fig. 3, is inserted in the same circuit, for illuminating the quadrant of the indicator during the night.

Fig. 7 shows the method of continuing the circuit by means of three spring contacts, running with the slider S on three thin plates of brass.

With this system, the "Forester" valve has an easy and uniform motion, and is not subjected to heavy shocks, as is the case with mechanical transmission, and the helmsman, by means of the indicator, which reproduces the movements of the tiller with the most desirable accuracy, is enabled to carry out the orders of his Commanding Officer with corresponding precision.

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THE GERMAN "FIELD[1] ARTILLERY EXERCISE," 1892.

The division of the book into five parts and an appendix, and the subdivision of these parts under different headings, correspond generally to those adopted in the 1889 edition, though the grouping under the different headings has been re-arranged.

The five parts are as follows:—

1st Part.—Drill without guns.

2nd Part.—Drill with guns, but without teams.

3rd Part.—Drill with guns and with the teams.

4th Part.—The fight.

5th Part.—Honours, inspections, fetching and returning the colours.

The following are the principal changes[2] introduced:—

1st Part.—Drill without Guns.

The sections of a battery are now subdivided for drill purposes into gun detachments of 4, or, when required, of 3, files, instead of, as formerly, into sub-sections of from 4 to 6 files. As the gun detachment for a field battery consists of 3 files, and that of a horse artillery battery of 4 files, this new arrangement is more natural, and corresponds more closely to the actual requirements when the guns are horsed.

2nd Part.—Drill with Guns, but without Teams.

The numbers 1 ("gun leader" in Germany) are now relieved of a great number of their former duties, such as fuzing the shell, manipulating the clinometer, &c., and are no longer detailed to remain in any particular place. They can thus devote their whole attention to the supervision of their gun detachments, for which they are held responsible, and to assisting and carrying out the instructions of the section leader.

The duties of the other numbers at the gun have been interchanged, with the result that a quicker and better service of the gun is obtained.

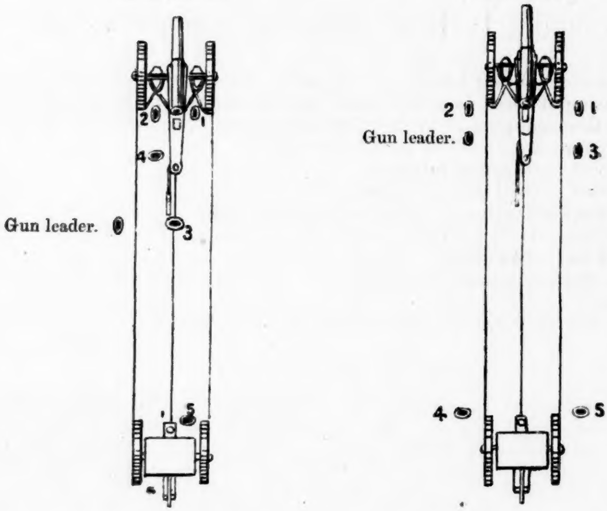
The gunners now all take post within the wheel-tracks at all times, except just before the gun is to be fired, thereby being nearer to their work and at the same time obtaining more cover. Only one gunner is now shown as taking post at the limber, whereas formerly two were shown.

[1] In Germany the field artillery includes horse artillery.

[2] Some of the changes mentioned have really been in force for some considerable time, but did not, however, appear in the 1889 edition of the "Field Artillery Exercise."

Posts of Gun Detachments.

As at present. As formerly.



When laying the gun for distances over 1,650 yards the clinometer is always to be set without any special word of command. The object is apparently to be able to change over to the sole use of the clinometer should this at any time be deemed advisable or necessary.

A new instrument, the "Richtfläche," has been introduced. This is made use of in conjunction with a lateral auxiliary mark, and enables a gun to be laid on an object which is unseen from the battery, but is visible from some elevated point in its vicinity.

The drag-rope has been re-introduced for moving unlimbered guns when on difficult soil.

In order to avoid losses in action, battery commanders may now, when on active service, or at manœuvres carried out under active service conditions, direct the whole of the gunners in the firing line to kneel down, only those men standing up whose duties at the moment may require them to do so. The giving of such an order is *permissive*, not obligatory.

The drill of a detachment by numbers is now carried out with the words of command for *shrapnel*, and not, as hitherto, for the *ring* shell.

Owing to the introduction of the *high-explosive* shell (Sprenggranate) a paragraph is devoted to the drill with this projectile.

The time and percussion fuze (Doppelzünder) is now used with the

shrapnel (instead of the old shrapnel fuze) as well as with the *high-explosive* shells.

Fresh paragraphs are also introduced with regard to changing from one fuze to another (*i.e.*, time to percussion and *vice versâ*), and, in the case of the *high-explosive* shell, about the extraction of the pellet.

It is now laid down that gun drill is to be carried out with reduced numbers, whereby it is expected that the men will get smarter at their drill and more ready to meet cases of emergency.

Throughout the drill, directions for the use of the brake apply to the new pattern brake ("Seil-Bremse").

3rd Part.—Drill with Guns and Teams.

Under the heading "Training of Young Horses for Draught Work" an addition has been made by the recommendation that young horses should for a considerable period be driven at a walk, in pairs, with a constantly increasing load.

The composition of a battery has undergone a complete reorganization, as will be seen from the following tables (p. 286).

It is now composed of the "*fighting battery*," the "*second échelon*," and the "*heavy baggage*."

The "*fighting battery*" is made up of 6 guns and the "*first échelon*," which latter consists of Nos. 1 to 4 ammunition wagons, together with officers' and spare horses. When forming part of an advanced guard, No. 4 ammunition wagon is to be replaced by a "*high-explosive*" ammunition wagon (*i.e.*, No. 8 or 9). In a field battery there are 5 officers' and 4 spare horses, and in a horse artillery battery 10 officers' horses.

The "*second échelon*" consists of ammunition wagons Nos. 5 to 9, No. 1 battery store wagon, and 6 spare horses.

The "*first and second échelons*" form the "*light baggage*." The "*heavy baggage*" comprises No. 2 battery store wagon, a field forge, a provision wagon, and a forage wagon.

The former "*fighting battery*" had only 3 ammunition wagons, but it had 1 battery store wagon, which has now been replaced by an ammunition wagon.

The first battery store wagon is now with the "*second échelon*;" the second battery store wagon, together with the field forge, have been consigned to the "*heavy baggage*," to which a provision wagon and a forage wagon have been added; whilst the third battery store wagon has been abolished altogether.

By this re-arrangement the present battery has only 16 carriages on the battle-field, as against 18 formerly, while at the same time it has more ammunition.

The distances between guns and wagons on the march have been reduced by 2 paces, whereby considerable space is saved.

When the guns unlimber and come into action, only 2 ammunition wagons, that is to say, one-half of the "*first échelon*," are, as a rule, brought up close to the guns, instead of, as formerly, the whole of the first line, viz., 3 wagons. These wagons now take post 10 paces

Composition of the Battery.

As at Present.

Fighting battery		No. 1 gun.
		No. 2 "
		No. 3 "
		No. 4 "
		No. 5 "
		No. 6 "
	First échelon[2]..	No. 1 ammunition wagon.
		No. 2 " "
		No. 3 " "
		No. 4[3] " "
		Officers' and spare horses.[4]
Light baggage[1]....	Second échelon[2]	No. 5 ammunition wagon.
		No. 6 " "
		No. 7 " "
		No. 8 " "
		No. 9 " "
		No. 1 battery store wagon.
		Spare horses.[4]
Heavy baggage[1] ..		No. 2 battery store wagon.
		Field forge.
		Provision wagon.
		Forage wagon.

As Formerly.

Fighting battery		No. 1 gun.
		No. 2 "
		No. 3 "
		No. 4 "
		No. 5 "
		No. 6 "
	First échelon[2]..	No. 1 ammunition wagon.
		No. 2 " "
		No. 3 " "
		No. 1 battery store wagon.
		Officers' horses.
	Second échelon[2]	No. 4 ammunition wagon.
		No. 5 " "
		No. 6 " "
		No. 7 " "
		No. 8 " "
		No. 2 battery store wagon.
		No. 3 " " "
		Field forge.
		Spare horses.

[1] The German terms are "kleine Bagage" and "grosse Bagage." "Kleine Bagage" is used throughout the German army to indicate the wagons, &c., *which immediately follow into action* the unit to which they belong. It will be noticed that the "kleine Bagage" consists only of ammunition wagons, a battery store wagon, and officers' and spare horses.

[2] Our *first* and *second lines.* The German word is "Staffel."

[3] In the case of advanced guards a high-explosive ammunition wagon (No. 8 or 9) takes the place of No. 4 ammunition wagon.

[4] *Field* battery { First échelon, 5 officers' and 4 spare horses. Second échelon, 6 spare horses.

Horse artillery battery { First échelon, 10 officers' horses. Second échelon, 6 spare horses.

in rear of the centre gun of each half battery, instead of, as formerly, in rear of the right gun of each section. It would seem that by this method the distance for serving the guns is precisely the same as before, whilst there is less exposure of men and matériel; at the same time the second half of the "*first échelon*" is always close at hand to replenish the supply when necessary.

4th Part.—The Fight.

It is now ordered that before the commencement of an action the artillery commander is to receive his instructions as to the conduct of the fight from the Commanding General.

Under the heading of "general principles" it is laid down as a fundamental principle that artillery is to be protected from hostile infantry fire by infantry pushed on in advance.

Firing over one's own troops is declared to be frequently unavoidable. The artillery commander is in duty bound, as soon as such fire becomes dangerous to his own advancing infantry, either to change his target or else to cease firing.

The construction of earthworks to protect the men is universally recommended, even in the attack, whenever time permits. They should be used extensively in prepared defensive positions. It will, however, only be practicable to provide cover for the limbers and ammunition wagons in positions which have been prepared some time in advance and in fortress warfare.

Instructions are now given how, when hostile cavalry have penetrated a battery, the combat is to be carried on with the revolver, officers and men getting under cover of the wheels, and the vehicles closing up. This is quite new.

To diminish losses, it is recommended that the men of a battery under the enemy's fire should kneel down.

Whilst, as before, it is stated that direct fire is preferable to indirect, it is now added that in certain special cases single batteries, concealed from view and difficult of discovery by the enemy, may be of great service in establishing a superiority of fire.

Under the heading "the choice of a position," it is now laid down that this depends mainly upon fire effect; the value of cover is explained later on, but in this particular connection it is not given prominence, as was the case in the 1889 edition of the "German Field Artillery Exercise."

In the old edition, masks were stated to be advantageous only when at least from 110 to 220 yards in front of the battery. Now every form of mask is held to be advantageous, as it increases the difficulty of observation for the enemy.

The interval between the guns should never, if possible, be less than 10 paces. Intervals between batteries should be about 30 paces (not as before from 30 to 50 paces).

Owing to the introduction of smokeless powder, the former references to the effect of the wind upon the smoke have now been expunged.

Under the heading "advancing and coming into position," it is advocated, as before, that this should be done under cover as much as possible, but the words "where this does not interfere with the fire effect" are now added, the meaning apparently being that a battery should endeavour to come into action unobserved, if possible, but that it is better to be observed than to lose fire effect on coming into action. The actual wording is: "Great value is to be attached to coming into position unobserved ('gedecktes Einnehmen der Stellung'), where this can be effected without detriment to the fire effect, and also upon a sudden opening of fire. Where there is no cover, or where it cannot be properly utilized, the object in view must be sought for by rapidity of movement."

A new paragraph has been inserted to the effect that in coming into position this must be so arranged that any unnecessary delay in coming into action will be avoided.

The heading "replenishing of ammunition, &c.," commences with the instructions that the supply of ammunition must be pushed forward to the front, even without the receipt of orders or of a demand therefor. It is clearly intended that the supply should be offered—not called for.

The "*second échelons*" are now to follow immediately in rear of the various units of the artillery arm (divisional, corps artillery, &c.), except in the case of advanced guards, when they follow in rear of all. Formerly the "*second échelons*" were separated from the guns to which they belonged, and followed in rear of the fighting troops of each independent unit.

The position of the "*second échelon*" is dependent entirely upon the locality. It is to be chosen as close to the firing line as is consistent with the safe supply of the ammunition; this will be, in open country, not more than about 660 yards. Formerly a distance of about 880 yards was deemed most suitable.

As soon as the "*second échelon*" is in position, it sends forward 2 ammunition wagons per battery to the "*first échelon*." Formerly 3 were sent.

Under "conduct of the fire" we are told that, where infantry is the target, fire is to be directed upon the most advanced line; against lines of skirmishers an endeavour should be made to leave no portion untouched by fire. Where closed bodies offer a favourable mark, they may frequently be fired upon with advantage, owing to the effect this will have on the more advanced line.

A greater rapidity of fire is now expected from batteries than formerly. On an average, a battery of 6 guns should fire about 4 rounds per minute, while with "rapid fire" it can, for a few minutes, maintain a rate of up to 10 rounds per minute.

There are now 4 different projectiles in use in the field artillery, as against the 3 natures previously employed—

1. *Ring shell* used for range-finding, against the more solid natures of targets, such as earthworks, &c., and, in the event of shrapnel running short, also against troops.

2. *Shrapnel*, with time fuze, is the principal projectile for use against all troops when not under cover; when set at zero it can, in the absence of case shot, be used at close quarters.
3. *High-explosive shell*, with *time* fuze, is for use against troops under cover; with *percussion* fuze, for distances beyond the range of shrapnel. It may also be used like the ring shell.
4. *Case shot*, for close ranges against troops up to 330 yards.

Under the heading "attack," it is laid down that the only occasion on which the intervals between guns in line may be totally disregarded is in the case of the successful issue of a combat, when the mass of the artillery presses forward to pursue the beaten enemy with fire. Here everything gives way to maintaining an overwhelming fire.

Under "retreat," it is directed that the ammunition échelons should be sent early to the rear, so as to be available in any new position to be taken up, and to facilitate the withdrawal of the guns. These measures are probably, to some extent, due to the fact that the *échelons* are now nearer to the fighting line than formerly.

In the "combat of horse artillery in conjunction with independent cavalry" there are several changes. The leader of the independent cavalry has now to decide whether he will make use of his horse artillery or not. In the former case he must give his orders early; in the latter case it may be desirable to leave them behind in a suitable position. The duty of protecting the artillery against hostile attacks falls to the lot of the nearest troops; if necessary, a special escort may be allotted.

The old axiom, that during the cavalry combat it will, under certain circumstances, be well to await events with the guns limbered up, is reintroduced.

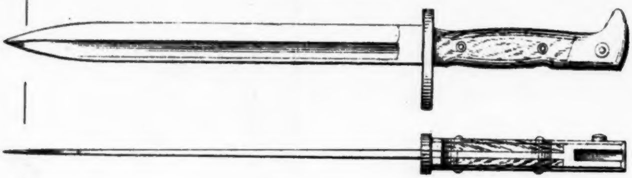
In a general engagement, it will be best not to retain the artillery allotted to the cavalry units with the latter, as they will be more advantageously employed, along with the other arms, in gaining the victory, and should only be again given back to the cavalry arm when the latter has to carry out some special duty.

5th Part.—Honours, Inspections, &c.

The changes here are of small importance.

(100.)

FIG. 4. SWORD-BAYONET ($\frac{1}{4}$).



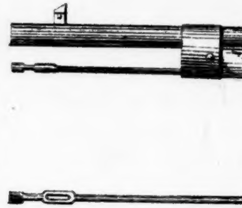


FIG. 5. SCABBARD ($\frac{1}{4}$).

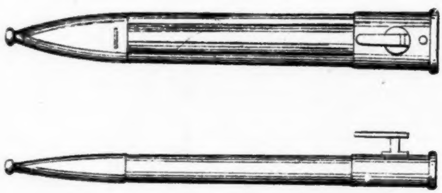


FIG. 9. EJECTOR ($\frac{1}{2}$).

FIG. 10. EXTRACTOR ($\frac{1}{2}$).

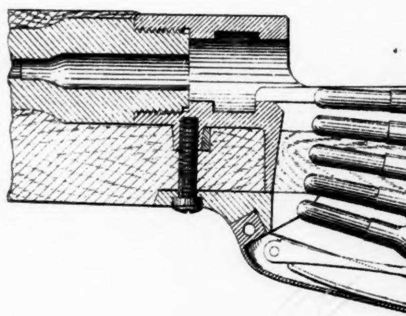
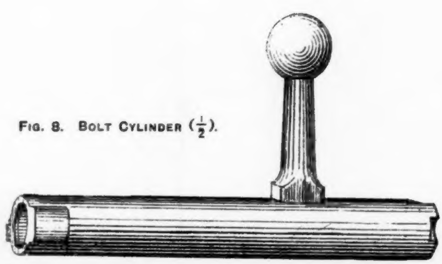


FIG. 11. BOLT-HEAD ($\frac{1}{2}$).

LEFT SIDE. RIGHT SIDE.

FIG. 8. BOLT CYLINDER ($\frac{1}{2}$).



FIG

6·5 M.M. (0″·2569 MAGAZINE RIFLE, MANNLICHER SYSTEM).

Fig. 1. Complete Rifle ($\frac{1}{4}$) Elevation.

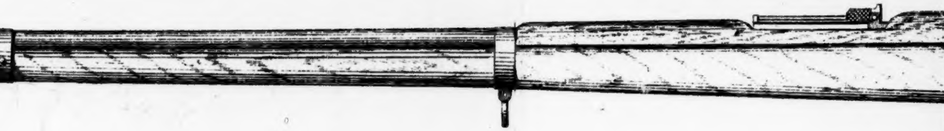


Fig. 3. Cleaning Rod ($\frac{1}{4}$).

Fig. 2. Plan ($\frac{1}{4}$).

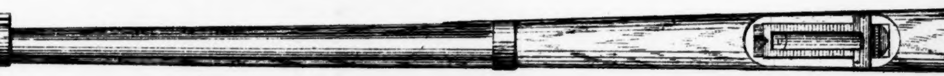
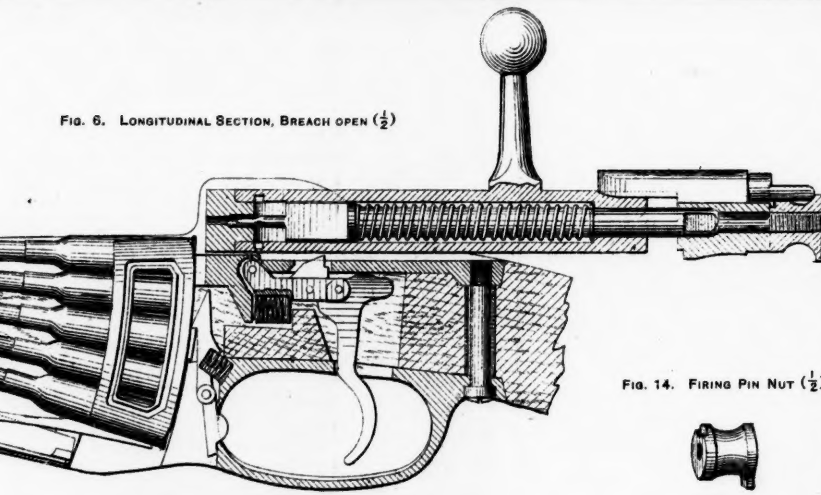


Fig. 6. Longitudinal Section, Breach open ($\frac{1}{2}$)



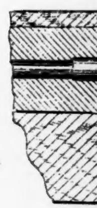


Fig. 14. Firing Pin Nut ($\frac{1}{2}$).

Fig. 12. Mainspring ($\frac{1}{2}$).

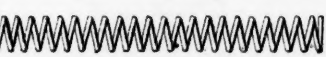


Fig. 15. Bolt ($\frac{1}{2}$).

Fig. 13. Firing Pin ($\frac{1}{2}$).

Harrison & Sons. Lith. St Martins Lane W.C.

FLE, MANNLICHER SYSTEM).

FIG. 1. COMPLETE RIFLE ($\frac{1}{4}$) ELEVATION.

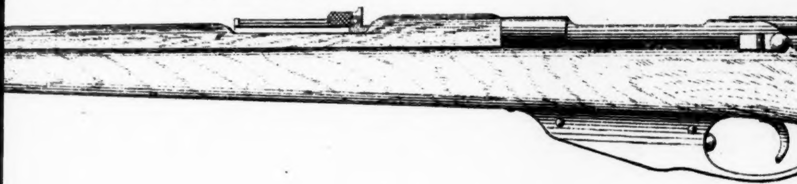
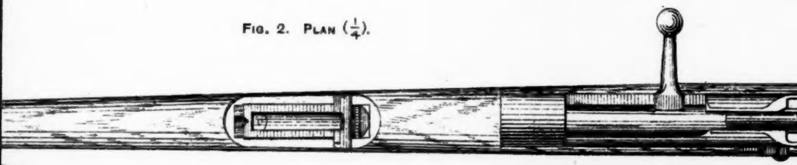


FIG. 2. PLAN ($\frac{1}{4}$).



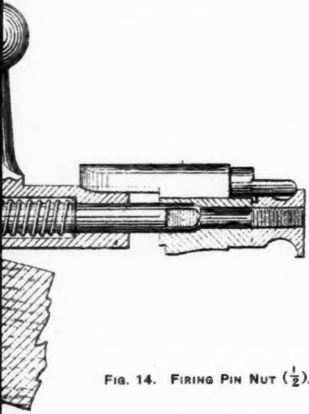


FIG. 7. LONGITUDINAL
FIRST CARTR

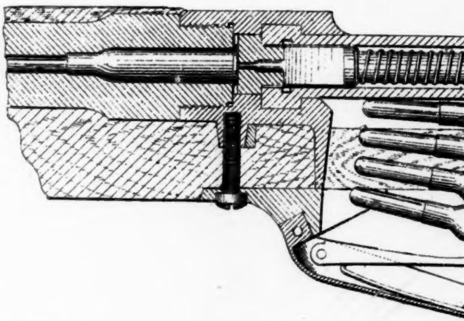


FIG. 14. FIRING PIN NUT ($\frac{1}{2}$).

FIG. 15. BOLT ($\frac{1}{2}$).

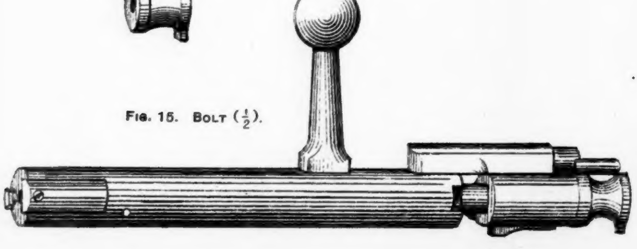
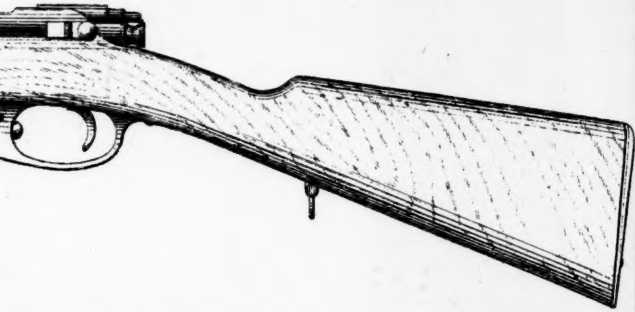


FIG. 16. S



Longitudinal Section after firing of First Cartridge ($\frac{1}{2}$).

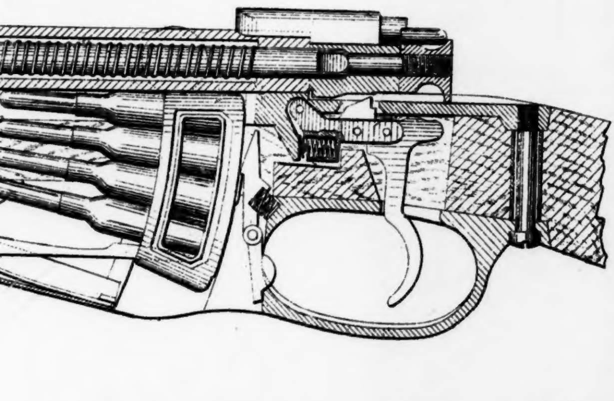


Fig. 16. Safety Bolt ($\frac{1}{2}$).

Fig. 17. Safety Bolt Spring ($\frac{1}{2}$).

Fig. 18. Cocking Piece ($\frac{1}{2}$).

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THE MAGAZINE RIFLE OF 6·5 MM. (0·2569 IN.) CALIBRE, MANNLICHER SYSTEM.

By Captain of Artillery J. Fraenkel.

Translated, by permission, from the "Revue d'Artillerie," July, 1892, by Captain F. L. Nathan, Royal Artillery.

Note by Translator.—The 6·5 mm. Mannlicher rifle is being supplied from the Small-arms Factory at Steyr, in Austria, for the Roumanian army. The same rifle, with some slight modifications introduced by M. Carcano of the Turin Small-arms Factory, and known as "Pattern 1891," has been definitely adopted by Italy, and a rifle of the same calibre and on the same system is being experimented with on an extended scale in Holland, with a view to adoption.

An outline of the ballistic properties of the 6·5 mm. Mannlicher rifle, translated from a notice in the September, 1892, number of the "Jahrbücher für die Deutsche Armee und Marine," which itself was taken from the article which follows, appeared in the December, 1892, number of this Journal. The results obtained by the Vienna Technical Committee at the trial of this rifle, the calibre of which is at present the lowest yet reached, except perhaps experimentally, are however so important, that a translation of the whole of the original article in the "Revue d'Artillerie" is appended.—F. L. N.

The principal advantages obtained by the reduction in calibre from 11 mm. (0·433 in.) to 8 mm. (0·3149 in.), together with the adoption of nitrogen powders, viz., reduction in the weight of the ammunition, increase of muzzle velocity, and consequently in the flatness of the trajectory, increased penetration, even at long ranges, &c., are well known. It is to the decrease in calibre, and also to the smokeless properties of the new powders, that to a great extent is to be attributed the rapid development in European armies, during the last few years, of magazine arms.

Until recently the military rifle of smallest calibre was the Swiss rifle, Pattern 1889, of 7·5 mm. (0·2953 in.). In 1891, M. Mannlicher, the engineer of the Steyr Small-arms Factory, still further decreased the calibre, constructing a magazine rifle of 6·5 mm. (0·2569 in.). This rifle, which was on the lines of the one adopted in the same year by Italy,[1] has been tried by several Powers. Austria, which had

[1] See "Revue d'Artillerie," June, 1891. The details of the construction of this rifle are not yet known; it is probable, however, that the pattern is already definitely settled, because, according to several French and foreign journals, an order for 800,000 rifles has been given by the Italian Government to the Austrian Small-arms Factory, at Steyr. The rifles will be on the Mannlicher-Carcano system, and the whole order is to be completed in thirty months.

recently armed herself with a small calibre rifle, did not consider that the advantages of the new arm were commensurate with the expense which a fresh change would entail. (Such was the War Minister's opinion, pronounced before Parliament during the 1892 Budget discussion.) The same was not the case with Roumania, who, having no small calibre rifle, decided upon the adoption of the new arm ("Revue d'Artillerie," February, 1892). Holland, similarly situated, will apparently follow Roumania's example ("Revue d'Artillerie," June, 1892).

The results of the experiments carried out in Austria have been published officially ("Experiments with 6·5 mm. (0·2569 in.) Calibre Magazine Rifles," July, 1891) by the Technical and Administrative Military Committee at Vienna. A description of the rifle has also been kindly placed at our disposal by the Steyr factory. What follows has been in great part taken by us from these two sources.

In the concluding remarks, the principal advantages of this rifle over those of 8 mm. (0·3149 in.) calibre are recapitulated, and some information is given about the smallest calibre, taken from some foreign publications.

A. *Description of the* 6·5 *mm.* (0·2569 *in.*) *Rifle.*

The 6·5 mm. (0·2569 in.) Mannlicher system magazine rifle (Figs. 1—7) reproduces the chief features of the German rifle, Pattern 1888, of which a detailed description is given in the Revue.[1]

The most important differences consist in the reduction in calibre, in the omission of the barrel casing, in some modifications in the bolt and magazine mechanism, in the sighting, and in the furniture. These differences will be noted in briefly recapitulating certain details of construction which are already familiar.

Barrel.—The barrel is covered by a wooden hand-guard, cut out for the sight and secured by two curved springs, which extends from the body to the middle band. This arrangement allows the rifle to be laid hold of by the barrel however hot the latter may be.

The four grooves have a length of 20 cm. (7·874 in.), or about 31 calibres.

The sight slide has a spring catch with tooth, which engages in suitable notches cut in the left side of the leaf. When the rifle is at the shoulder, the slide can be raised by the thumb of the left hand and fixed at any elevation.

The bayonet is attached to the upper band.

Bolt Mechanism (Figs. 6—18).—The bolt cylinder has two locking lugs in front, opposite to one another, and horizontal when the breech is open; the right lug is cam-shaped, and serves to start the extraction of the cartridge.

[1] See "Revue d'Artillerie," March, 1890. The German rifle is also due to Mr. Mannlicher, who, in adopting for it the magazine arrangement, of which he is the inventor, retained the Mauser bolt of the old German rifles, Patterns 1871 and 1884. (For a description of the German Rifle, Pattern '88, see also "Engineering," May 15, 1891.—F. L. N.)

The movable bolt-head, which does not rotate with the bolt, has a flat face; on the left it carries the ejector, on the right the extractor, which both project beyond its face.

The ejector has a projection of dovetail form, which can travel backwards and forwards in a longitudinal groove in the bolt-head. It acts as follows:—When the bolt cylinder is turned down to the right, the ejector rests in its recess in the front of the body, and keeps the bolt-head in its place. When the lever is raised into the vertical position, the left locking lug is in position to actuate the ejector. Finally, in the last portion of the travel to the rear of the bolt, the ejector is caught by a spring tappet fixed in the body, which pushes the ejector to the front, the latter throwing out the empty cartridge case.

The cartridge, on leaving the magazine, is immediately caught by the hook of the extractor, and thus accompanies the bolt mechanism in all its backward and forward movements. This arrangement is to prevent "double loading," that is to say, the ascent of the top cartridge in the magazine before the preceding cartridge has been extracted.[1]

Magazine Mechanism (Figs. 6 and 7).—The magazine forms one component with the trigger-guard, and contains the feeding lever actuated by a flat spring, and the catch for the clip, with spiral spring. It receives a steel clip containing five cartridges. When the last cartridge has left the clip, the latter falls by its own weight out of the opening in the bottom of the magazine; if it does not do so, the introduction of the next clip suffices to throw it out. To remove a clip still containing cartridges, all that is necessary is to open the bolt and press the button of the catch with the finger.

Cartridge.—The cartridge, with rim, proposed by the maker contains a charge of 2·35 gm. (36·25 gr.) of Troisdorf powder,[2] giving a muzzle velocity of 700 m. (2,296·6 ft.-sec.).

The lead bullet has a steel or nickel envelope, and weighs 10·5 gm. (162 gr.).

The cartridge is 77·7 mm. (3·059 in.) long, and weighs 22·7 gm. (350·3 gr.).

The five cartridges are contained in the clip as follows:—The three middle ones with their rims side by side, the other two with their bases in front of the rims of the adjacent ones.

The weight of the clip is about 9·5 gm. (146·6 gr.).

[1] In rifles in which the hook of the extractor only engages the rim of the cartridge when the latter is entirely in the chamber, if for any reason the bolt is drawn completely back before the engagement has taken place, a second cartridge enters the body from the magazine. If then the closing of the bolt is attempted, the action becomes jammed; it might even happen that the second cartridge, acting as a striker, would fire the first one.

[2] This powder, made by the Rhenish Westphalian Explosives Company at Troisdorf, near Cologne, has a gun-cotton base, and does not contain nitro-glycerine. It is in the shape of small regular flakes, like the official German powder; it is blackleaded.

B. *Results of firing carried out by the Austro-Hungarian Artillery.*

The Technical and Administrative Committee of Vienna carried out experiments with the 6·5 mm. (0·2569 in.) Mannlicher system magazine rifle, to obtain information about the value of the rifle, as well as to enable the Steyr factory to graduate the sights and ascertain other ballistic details.

The rifles placed at the disposal of the Committee were of two patterns, differing only in length of barrel. The principal dimensions of the two patterns, one called "long" and the other "short," are given in the following table:—

TABLE I.—*Weights and Dimensions of the Rifles and Ammunition.*

	Magazine rifles 6·5 mm. (0·2569 in.).	
	Short.	Long.
Total length	1,225 mm. (48·22 in.)	1,285 mm. (50·58 in.)
" weight	3·845 kilos. (8·46 lb.)	3·935 kilos. (8·66 lb.)
Length of barrel	730 mm. (28·74 in.)	790 mm. (31·1 in.)
" rifling	653·5 mm. (25·73 in.)	713·5 mm. (28·09 in.)
" chamber	76·5 mm. (3·01 in.)	76·5 mm. (3·01 in.)
" sight radius	593 mm. (23·35 in.)	660 mm. (25·98 in.)
Grooves, number	4	4
" depth	0·15 mm. (0·0059 in.)	0·15 mm. (0·0059 in.)
" twist	200 mm. (7·874 in.)	200 mm. (7·874 in.)
Cartridge, length	76·5 mm. (3·01 in.)	76·5 mm. (3·01 in.)
" weight	21·9 gm. (33·8 gr.)	21·9 gm. (33·8 gr.)
Bullet, length	31·4 mm. (1·236 in.)	31·4 mm. (1·236 in.)
" weight	10·5 gm. (162 gr.)	10·5 gm. (162 gr.)
" maximum diameter	6·7 mm. (0·2638 in.)	6·7 mm.) (0·2638 in.)

The experiments were to determine—

1. The muzzle velocity.
2. Ordinates of the 600 paces (450 m., 492 yds.) trajectory.
3. The penetration of the bullet.
4. The angle of jump.
5. The sighting, and cone of dispersion.

1. *Determination of the Muzzle Velocity.*

The muzzle velocity was ascertained by measuring, by means of the Boulangé chronograph, the velocity at 25 m. (27·34 yds.) from the muzzle.

The weights of Nobel's ballistite and of Austrian smokeless powder, Pattern 1890, capable of giving a velocity of 700 m. (2,296·6 ft.-sec.) at 25 m. (27·34 yds.) were first ascertained. To study then the influence of the length of barrel, comparative rounds were fired from the two rifles with the ascertained charges, and the velocities at 25 m. (27·34 yds.) measured. For the short rifle, charges first filled by weight and then by volume were also tried, to judge the relative values of these two methods of filling.

The results obtained are given in Table II. They show, firstly, equal results from charges of 2·1 gm. (32·4 gr.) of ballistite and

TABLE II.—*Velocity Experiments with Charges of* 2·1 *gm.* (32·4 *gr.*) *of Ballistite, and* 2·6 *gm.* (40·12 *gr.*) *of Powder, Pattern* 1890.

Short rifle.				Long rifle.	
Charge.	Velocity at 25 m. (27·34 yds.) in metres and f.s.	Charge.	Velocity at 25 m. (27·34 yds.) in metres and f.s.	Charge.	Velocity at 25 m. (27·34 yds.) in metres and f.s.
2·1 gm. (32·4 gr.) Ballistite (weighed).	713·5 m. (2340·92 f.s.) 700 m. (2296·63 f.s.) 703 m. (2306·47 f.s.) 700 m. (2296·63 f.s.) 703·5 m. (2308·11 f.s.) 710 m. (2329·44 f.s.) 703 m. (2306·47 f.s.) 700·5 m. (2298·27 f.s.) 701 m. (2291·91 f.s.) 709·5 m. (2327·8 f.s.)	2·6 gm. (40·12 gr.) Pattern 1890 powder (weighed).	711 m. (2332·72 f.s.) 710 m. (2329·44 f.s.) 710 m. (2329·44 f.s.) 706·5 m. (2317·95 f.s.) 710 m. (2329·44 f.s.) 708·5 m. (2324·52 f.s.) 708 m. (2322·88 f.s.) 710 m. (2329·44 f.s.) 710·5 m. (2334·36 f.s.) 710 m. (2329·44 f.s.)	2·6 gm. (40·12 gr.) Pattern 1890 powder (weighed).	715 m. (2345·84 f.s.) 713 m. (2339·28 f.s.) 708 m. (2322·88 f.s.) 713 m. (2339·28 f.s.) 715 m. (2345·84 f.s.) 707 m. (2319·60 f.s.) 706 m. (2316·31 f.s.) 711 m. (2332·72 f.s.) 706 m. (2316·31 f.s.) 713 m. (2339·28 f.s.)
Mean.....	704·4 m. (2311·06 f.s.)	Mean.....	709·4 m. (2327·47 f.s.)	Mean.....	710·7 m. (2331·73 f.s.)
Max. diff..	13·5 m. (44·3 f.s.)	Max. diff..	4·5 m. (14·76 f.s.)	Max. diff..	9·0 m. (29·53 f.s.)

TABLE II—*continued.*

Short rifle.

Charge.	Velocity at 25 m. (27·34 yds.) in metres and f.s.	Charge.	Velocity at 25 m. (27·31 yds.) in metres and f.s.
2·1 gm. (32·4 gr.) Ballistite (measured).	723 m. (2372·09 f.s.) 695·1 m. (2280·54 f.s.) 705 m. (2313·03 f.s.) 700 m. (2306·47 f.s.) 705 m. (2313·03 f.s.) 702 m. (2303·19 f.s.) 701 m. (2299·91 f.s.) 681·7 m. (2236·54 f.s.) 690 m. (2263·82 f.s.) 697·4 m. (2288·1 f.s.)	2·6 gm. (40·12 gr.) Pattern 1890 powder (measured).	708·5 m. (2324·52 f.s.) 712 m. (2336·00 f.s.) 713 m. (2339·28 f.s.) 712 m. (2336·00 f.s.) 722 m. (2368·81 f.s.) 687 m. (2253·98 f.s.) 711 m. (2332·72 f.s.) 707 m. (2319·6 f.s.) 709 m. (2326·16 f.s.) 707 m. (2319·6 f.s.)
Mean........	700·8 m. (2299·25 f.s.)	Mean........	708·8 m. (2325·5 f.s.)
Max. diff.....	41·3 m. (135·5 f.s.)	Max. diff......	35·0 m. (114·83 f.s.)

Atmospheric conditions during the experiment—
Height of barometer, 748 mm. (29·45 in.).
Temperature, +20° C. (68° F.).
Moisture, 50 per cent.

2·6 gm. (40·12 gr.) of Pattern 1890 powder; and secondly, that it is advantageous, for regularity of velocity, to weigh the charges. This system was therefore adopted by Keller and Co., who had received the order for the ammunition.

The cartridges made by Keller and Co. contain 2·1 gm. (32·4 gr.) of ballistite, giving for 10 rounds a mean velocity at 25 m. (27·34 yds.) of 712 m. (2,336 ft.-sec.), with a maximum difference of 15 m. (49·2 ft.-sec.)

As their bullets were more greased than those previously experimented with, made in the workshops of the Military Committee, the effect of this greasing was ascertained. For this purpose a second series of 10 cartridges were fired after the grease had been carefully removed; a velocity at 25 m. (27·34 yds.) of 697·6 m. (2,288·75 ft.-sec.), with a maximum difference of 17 m. (55·77 ft.-sec.), was obtained.

705 m. (2,313·03 ft.-sec.) was taken as the mean velocity at 25 m. (27·34 yds.) for the short rifle, and taking for the resistance of the air the law of the 4th power, a law previously taken for calculating other elements of the trajectory, a muzzle velocity of 730 m. (2,395·06 ft.-sec.) was obtained.

2. *Determination of the Ordinates of the* 450 *m.* (492·13 *yds.*) *Trajectory.*

The following results (Table III) were obtained, in which each ordinate represents the mean value of ten observations :—

TABLE III.—450 *m.* (492·13 *yds.*) *Trajectory.*

Distances in metres	0	75	150	225	262·5	300	375	450
„ yards .	(0)	(82)	(164)	(246)	(287)	(328)	(411)	(492)
Ordinates in cm. . .	0	43·5	69·5	80·5	81·5	77	51	0
„ inches	(0)	(17·12)	(27·37)	(31·6)	(32·8)	(30·31)	(20·08)	(0)

3. *Determination of the Penetration of the Bullets.*

The firing took place at short ranges against a block of copper beech, at long ranges against fir panels. The results are given in Table IV. The firing at short ranges was not continued, as it soon showed sufficiently the superiority in penetration of the steel enveloped 6·5 mm. (0·2569 in.) bullet, over the 8 mm. (0·3149 in.) bullet with similar envelope, adopted in many countries; the latter with a muzzle velocity of 600 m. (1,968·54 ft.-sec.) to 630 m. (2,066·97 ft.-sec.) only penetrated, under similar conditions, 50 c. (19·68 in.) to 56 c. (22·04 in.) of red beech.

TABLE IV.—*Penetration Results.*

Range.	Target.	Penetration.	Remarks.
12 m. (13·12 yds.)	Copper beech (20 boards, each 4 cm. (1″·575) thick, screwed together one behind the other).	69 cm. (27·16 ins.)	Mean of 4 rounds. The bullets, of hard lead, with steel envelopes, showed signs of fusion at the base.
1,500 m. (1,640 yds.)	Panels made of fir joists 15 cm. (5′·9) thick)	Penetrated.	
2,500 m. (2,734 yds.)		11 cm. (4″·33 ins.)	

TABLE V.—*Range Table for the 6·5 mm. (0·2569 in.) Short Rifle.*

Ranges.	Angles of departure.			Heights of sight.[1]	Angles of descent.			Times of flight in seconds.	Remaining velocities.	Dangerous space for an object 1 m. (3·28 ft.) in height, fired at from a rest at the height above the ground of		Double probable deviation.	
	°	′	″		°	′	″			1·5 m. (4·92 ft.)	0 m. (0 ft.)	Vertical.	Horizontal.
100 m. (109·3 yds.)	0	4	0	−1·90 mm. (0·748 in.)	0	0	50	0·14	650 m. (2,152 f.s.)	135 m. (442·9 ft.)	..	0·03 m. (0·098 ft.)	0·02 m. (0·066 ft.)
200 m. (218·7 yds.)	0	8	25	−1·00 mm. (0·03937 in.)	0	10	30	0·30	580 m. (1,903 f.s.)	140 m. (459·3 ft.)	..	0·06 m. (0·197 ft.)	0·05 m. (0·164 ft.)
300 m. (328 yds.)	0	13	20	−0·10 mm. (0·0039 in.)	0	17	10	0·48	530 m. (1,738 f.s.)	125 m. (410·1 ft.)	..	0·10 m. (0·328 ft.)	0·09 m. (0·295 ft.)
400 m. (437·4 yds.)	0	18	55	+0·90 mm. (0·0354 in.)	0	25	10	0·68	490 m. (1,607 f.s.)	100 m. (328·1 ft.)	..	0·15 m. (0·492 ft.)	0·14 m. (0·459 ft.)
500 m. (546·8 yds.)	0	25	10	2·00 mm. (0·0787 in.)	0	34	40	0·90	445 m. (1,460 f.s.)	80 m. (262·4 ft.)	..	0·21 m. (0·689 ft.)	0·19 m. (0·623 ft.)
600 m. (652·6 yds.)	0	32	15	3·15 mm. (0·124 in.)	0	45	50	1·14	419 m. (1,375 f.s.)	65 m. (213·2 ft.)	..	0·28 m. (0·918 ft.)	0·24 m. (0·787 ft.)
700 m. (765·5 yds.)	0	40	10	4·45 mm. (0·1752 in.)	0	58	50	1·40	394 m. (1,292 f.s.)	50 m. (164 ft.)	..	0·36 m. (1·181 ft.)	0·30 m. (0·984 ft.)
800 m. (875 yds.)	0	49	15	6·00 mm. (0·2362 in.)	1	13	50	1·69	371 m. (1,217 f.s.)	38 m. (124·6 ft.)	45 m. (147·6 ft.)	0·45 m. (1·476 ft.)	0·36 m. (1·181 ft.)
900 m. (984·3 yds.)	0	59	30	7·80 mm. (0·3071 in.)	1	31	10	2·01	350 m. (1,148 f.s.)	..	37 m. (121·4 ft.)	0·55 m. (1·804 ft.)	0·44 m. (1·443 ft.)
1000 m. (1,093·6 yds.)	1	11	30	9·85 mm. (0·3878 in.)	1	51	20	2·36	330 m. (1,082 f.s.)	..	31 m. (101·7 ft.)	0·66 m. (2·165 ft.)	0·52 m. (1·706 ft.)

1,100 m. (1,203 yds.)	1	25	50	12·30 mm. (0·4843 in.)	2	16	20	2·74	311 m. (1,020 f.s.)	..	26 m. (85·3 ft.)	0·78 m. (2·558 ft.)	0·66 m. (2·165 ft.)
1,200 m. (1,312·3 yds.)	1	42	30	15·20 mm. (0·5984 in.)	2	46	10	3·15	294 m. (964 f.s.)	..	21 m. (68·9 ft.)	0·91 m. (2·985 ft.)	0·80 m. (2·624 ft.)
1,300 m. (1,421·7 yds.)	2	1	30	18·50 mm. (0·7284 in.)	3	20	50	3·59	279 m. (915 f.s.)	..	17 m. (55·7 ft.)	1·05 m. (3·445 ft.)	0·96 m. (3·149 ft.)
1,400 m. (1,531·1 yds.)	2	22	50	22·15 mm. (0·8720 in.)	4	0	20	4·06	265 m. (869 f.s.)	..	14 m. (45·9 ft.)	1·20 m. (3·937 ft.)	1·14 m. (3·74 ft.)
1,500 m. (1,640·4 yds.)	2	46	40	26·30 mm. (1·0354 in.)	4	44	40	4·56	252 m. (826 f.s.)	..	12 m. (39·3 ft.)	1·40 m. (4·593 ft.)	1·34 m. (4·396 ft.)
1,600 m. (1,749·8 yds.)	3	13	0	30·85 mm. (1·2146 in.)	5	33	50	5·09	240 m. (787 f.s.)	..	10 m. (32·8 ft.)	1·70 m. (5·577 ft.)	1·59 m. (5·216 ft.)
1,700 m. (1,859·2 yds.)	3	41	50	35·80 mm. (1·4095 in.)	6	27	50	5·65	229 m. (751 f.s.)	..	8·5 m. (27·8 ft.)	2·10 m. (6·890 ft.)	1·90 m. (6·233 ft.)
1,800 m. (1,968·5 yds.)	4	13	10	41·25 mm. (1·624 in.)	7	26	40	6·24	219 m. (718 f.s.)	..	7·5 m. (24·6 ft.)	2·60 m. (8·53 ft.)	2·30 m. (7·546 ft.)
1,900 m. (2,078 yds.)	4	47	0	47·10 mm. (1·8544 in.)	8	30	30	6·86	210 m. (689 f.s.)	..	6·5 m. (21·3 ft.)	3·30 m. (10·827 ft.)	2·80 m. (9·186 ft.)
2,000 m. (2,187·2 yds.)	5	23	20	53·40 mm. (2·0882 in.)	9	39	20	7·51	202 m. (662 f.s.)	..	5·5 m. (18·0 ft.	4·20 m. (13·78 ft.)	3·40 m. (11·155 ft.)
2,100 m. (2,296·6 yds.)	6	2	40	60·25 mm. (2·3681 in.)	10	53	10	8·19	195 m. (640 f.s.)	..	5 m. (16·4 ft.)	5·40 m. (17·717 ft.)	4·10 m. (13·451 ft.)
2,200 m. (2,406 yds.)	6	45	0	68·00 mm. (2·6772 in.)	12	12	30	8·90	189 m. (620 f.s.)	..	4·5 m. (14·7 ft.)	7·00 m. (22·966 ft.)	4·90 m. (16·076 ft.)
2,300 m. (2,515·3 yds.)	7	31	20	75·75 mm. (2·9823 in.)	13	37	50	9·64	184 m. (603 f.s.)	..	4 m. (13·1 ft.)	9·00 m. (29·528 ft.)	5·80 m. (19·09 ft.)
2,400 m. (2,624·7 yds.)	8	21	40	84·60 mm. (3·3307 in.)	15	9	40	10·41	179 m. (587 f.s.)	..	3·5 m. (11·4 ft.)	12·00 m. (39·371 ft.)	6·80 m. (22·31 ft.)
2,500 m. (2,734 yds.)	9	16	0	94·15 mm. (3·7067 in.)	16	50	30	11·21	174 m. (571 f.s.)	..	3 m. (9·84 ft.)	16·00 m. (52·494 ft.)	8·00 m. (26·247 ft.)

[1] The heights of sight are calculated by supposing the angle of jump to be equal to 14·5 minutes, and the sight radius equal to 593 mm. (23·35 in.)

4. *Determination of Angle of Jump.*

Several series of 10 rounds were fired against a target at 32 m. (35 yds.) from the muzzle, using different rifles. From the height of the back sight notch, and of the foresight, from the position of the mean point of impact, and from the muzzle velocity, the angle of jump was calculated, and was found to be equal to +14·5 minutes for the short and +13 minutes for the long rifle.

5. *Determination of the Sight Graduations, and the Cone of Dispersion.*

Firing was carried out at ranges of 150 m. (164 yds.), 300 m. (328 yds.), 450 m. (492 yds.), 600 m. (656 yds.), 800 m. (875 yds.), 1,000 m. (1,094 yds.), 1,200 m. (1,312 yds.), 1,500 m. (1,640 yds.), 2,000 m. (2,187 yds.), and 2,500 m. (2,734 yds.) with two short rifles; it consisted at each distance of 2 to 4 series, exclusive of the 5 to 10 preliminary rounds for determining the sight with which there was most chance of putting all the shots into the target. Each series consisted of from 15 to 80 rounds, according to the range. The rifles were fired from a rest by good shots.

The targets consisted either of a row of panels 2 cm. (0·787 in.) thick, 5·40 m. (17·72 in.) high, and 32 m. (105 ft.) long, or of several rows (up to 20) of the same thickness and height placed one behind the other, the height and distance apart being arranged to suit the curve of the different trajectories.

At each range the time of flight was measured by the telephone and Marenzeller chronometer.

From the results obtained, the various ballistic elements were calculated, using the formulæ adopted by the Military Committee. As already stated, the law of the 4th power of the resistance of the air was taken, the density of the air being 1·208.

The results of the calculations are given in Table V (p. 298).

TABLE VII.—*Co-ordinates of the Culminating Points.*

Range.		Culminating point.			
		Abscissæ.		Ordinates.	
Metres.	Yards.	Metres.	Yards.	Metres.	Feet.
1,200	1,312·36	710	776·48	12·70	41·667
1,400	1,531·09	820	896·78	21·88	71·786
1,600	1,749·81	940	1,028·02	35·37	116·046
1,800	1,968·54	1,070	1,170·18	53·56	175·725
2,000	2,187·27	1,210	1,323·3	77·20	253·285
2,500	2,734·08	1,500	1,640·45	165·90	544·3

TABLE VIII.—*Maximum Dangerous Spaces.*

Height of firing point, in metres and feet.	Height of target, in metres and feet.	Maximum dangerous space, in metres and yards.
1·5 m. (4·92 ft.) standing	1 8 m. (infantry standing) (5 9) ft. „ „ 2·7 m. (cavalry) (8·85 ft) „	500 m. (546·8 yds.) 645 m. (705·4 yds.)
0·4 m. (1·312 ft.) lying down	1·8 m. (infantry standing) (5·9 ft.) „ „ 2·7 m. (cavalry) (8·85 ft.) „	600 m. (656·18 yds.) 720 m. (787·41 yds.)

In conclusion, in Tables VI, VII, and VIII are given several other ballistic results, viz. :—

The ordinates of the trajectories up to 1,000 m. (1,094 yds.), the co-ordinates of the "culminating points" from 1,200 m. (1,312 yds.) to 2,500 m. (2,734 yds.), and the maximum "dangerous spaces" under certain given conditions.

C. Conclusion.

If the 6·5 mm. (0·2569 in.) Mannlicher magazine rifle be compared with similar magazine rifles (with central magazine) of 8 mm. (0·3149 in.), it is evident that it presents important advantages from a tactical as well as a ballistic point of view.

Compare, for example, the 7·9 mm. (0·311 in.) rifle, Pattern 1888, which most resembles it in its loading arrangements, and which consequently possesses about the same rapidity of fire.

Firstly, it will be noticed that the 6·5 mm. (0·2569 in.) ammunition is lighter, the bullet weighing only 10·5 gm. (162 gr.) instead of 14·5 gm. (223·7 gr.). The weight of a full clip is 120 gm. (1,852 gr.) instead of 155 gm. (2,392 gr.), so that, without an increase of weight, about a quarter as much again ammunition can be carried by the soldier, and the carts.

The muzzle velocity of the 10·5 gm. (162 gr.) bullet is 730 m. (2,395 ft.-sec.), that of the 14·5 gm. (223·7 gr.) only 630 m. (2,067 ft.-sec.). The resulting flatness of trajectory is sensibly greater, as will be seen from the following table :—

Range.		Ordinates at half range.			
		6·5 mm. rifle. (0·2569 in.)		7·9 mm. German rifle. (0·311 in.)	
Metres.	Yards.	Metres.	Feet.	Metres.	Feet.
500	546·8	1·04	3·412	1·5	4·92
600	656·1	1·65	5·413	2·5	8·2
800	875·0	3·53	11·581	5·4	17·72
1,000	1093·6	6·74	22·113	10·1	32·8

From an accuracy point of view the superiority is equally marked, but it is known that accuracy plays but a secondary part in warfare; the errors due to imperfections in the arm are always less than those resulting from the awkwardness of the firer, or the use of a wrong sight.

The velocity of recoil is less, 2 m. (6·56 ft.-sec.) instead of 2·4 m. (7·87 ft.-sec.), for practically the same weight of rifle [about 3·800 kilos. (8·277 lbs.) with empty magazine].

Finally, as regards the effects of penetration, we have seen that at a short range of 12 m. (13·12 yds.), the bullet penetrates 69 cm. (27·16 in.) of copper beech, instead of 50 cm. (19·68 in.) to 56 cm. (22·04 in.) penetrated by the 8 mm. (0·3149 in.) bullet. The report of the Military Committee does not give comparative penetrations at long ranges, but they can be supplied up to a certain point, by a consideration of the remaining velocities. For example, if the range table of the French rifle, Pattern 1886, is consulted, it is seen that at 2,000 m. (2,187 yds.) a 15 gm. (231·5 gr.) bullet has a remaining velocity of 160 m. (525 ft.-sec.); at the same range, the velocity of the 10·5 gm. (162 gr.) bullet is 202 m. (663 ft.-sec.). On calculating this out, the latter bullet will be found to possess a little more energy. If besides it is remembered that for the same total energy the power of penetration is greater in the same proportion as the diameter of the bullet is decreased, it may be concluded that at 2,000 m. (2,187 yds.) the power of penetration of the 6·5 mm. (0·2569 in.) bullet is certainly greater than that of the French bullet.

Looking to the superiority of this 6·5 mm. (0·2569 in.) rifle over existing rifles, one is led to ask if, with the new powders, it would not be advantageous to descend still lower in the scale of calibres.

In an article published recently in the "Schweizerische Militärische Blätter" (No. 3), Professor Hebler, in dealing with this question, does not hesitate to reply in the affirmative. After having stated the principle that every ballistic and tactical interest is in favour of as great a reduction in calibre as possible, the author brings forward in support of this theory, certain considerations which we think interesting to summarize.

In the present state of mechanical skill, he says it is possible,

TABLE V

Ordinates of the different Trajectories

Range in metres ... in yards	50 54·68	100 109·36	150 164	200 218·7	250 273·4	300 328	350 382·7	400 437
Trajectories of—								
200 m. .... (218·7 yds.)	0·09 m. (0·295 ft.)	0·13 m. (0·426 ft.)	0·10 m. (0·328 ft.)	0 m. (0 ft.)				
300 m. .... (328 yds.)	0·16 m. (0·525 ft.)	0·27 m. (0·886 ft.)	0·31 m. (1·017 ft.)	0·29 m. (0·918 ft.)	0·18 m. (0·59 ft.)	0 m. (0 ft.)		
400 m. .... (437·4 yds.)	0·25 m. (0·820 ft.)	0·43 m. (1·41 ft.)	0·56 m. (1·837 ft.)	0·61 m. (2·001 ft.)	0·59 m. (1·935 ft.)	0·49 m. (1·574 ft.)	0·30 m. (0·984 ft.)	0 m (0 ft.
500 m. .... (546·8 yds.)	0·34 m. (1·115 ft.)	0·62 m. (2·034 ft.)	0·83 m. (2·722 ft.)	0·98 m. (3·214 ft.)	1·04 m. (3·412 ft.)	1·03 m. (3·379 ft.)	0·93 m. (3·05 ft.)	0·73 (2·394
600 m. .... (656 yds.)	0·44 m. (1·443 ft.)	0·82 m. (2·69 ft.)	1·14 m. (3·74 ft.)	1·39 m. (4·56 ft.)	1·55 m. (5·085 ft.)	1·65 m. (5·413 ft.)	1·65 m. (5·413 ft.)	1·55 (5·085
800 m. .... (875 yds.)	”	1·32 m. (4·33 ft.)	”	2·38 m. (7·808 ft.)	”	3·13 m. (10·269 ft.)	”	3·53 (11·581
1,000 m. .... (1,093·6 yds.)	”	1·96 m. (6·43 ft.)	”	3·67 m. (12·03 ft.)	”	5·08 m. (16·667 ft.)	”	6·12 (20·079

LE VI.

ories up to 1,000 *m.* (1,093·6 *yds.*).

400 437·4	450 492·1	500 546 8	550 601·5	600 656	700 765·5	800 875	900 984·2	1,000 1,093·6
0 m. (0 ft.)								
0·73 m. 2·394 ft.)	0·41 m. (1·345 ft.)	0 m. (0 ft.)						
1·55 m. 5·085 ft.)	1·34 m. (4·396 ft.)	1·03 m. (3·379 ft.)	0·60 m. (1·968 ft.)	0 m. (0 ft.)				
3·53 m. 1·581 ft.)	,,	3·50 m. (11·483 ft.)	,,	2·97 m. (9·744 ft.)	1·85 m. (6·069 ft.)	0 m. (0 ft.)		
6·12 m. 0·079 ft.)	,,	6·74 m. (22·113 ft.)	,,	6·85 m. (22·474 ft.)	6·38 m. (20·932 ft.)	5·18 m. (16 995 ft.)	3·14 m. (15·202 ft.)	0 m. (0 ft.)

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without too many difficulties, to descend to a calibre of 5 mm. (0·197 in.).[1] The calibre of the rifle, the wounds from which cease to place men *hors de combat* for a sufficiently long time, has not yet been practically determined; anyhow it is certainly below this figure.

As regards pressure, it will reach 4,500 atmospheres ($29\frac{1}{2}$ tons on the square inch), even with the best types of known powders. Therefore to prevent the bolt opening, it will be necessary that the resisting surfaces of the lugs should be increased; the use of four instead of two lugs, proposed by M. Krnka, will enable this condition to be very satisfactorily fulfilled.

Objection has been made that with such a high pressure the chamber will be deformed, and that the cases will stick to the lead. If however it is calculated out, it will be seen that the deformation of the chamber cannot take place, "because the limit of elasticity of the cast steel, of which the chamber is made, is not reached." Besides, taking the small diameter of the cartridge into account, the case will not commence to enter the lead under a pressure much greater than 5,000 atmospheres ($32\frac{3}{4}$ tons on the square inch).

Finally, as regards difficulties in cleaning the barrel, they can be overcome by using a pull-through, similar to the Swiss one, which has only a secondary inconvenience, the necessity of two men for its use.

Professor Hebler announces in the same article, that he designed, and had made, in June 1891, patterns of 5 mm. (0·197 in.) cartridges; unfortunately, he does not give any indication of the construction of the bullet, of its weight, nor of the velocity he expects to obtain with a pressure of 4,500 atmospheres which he considers admissible. It would be very interesting to know these details, for if the bullet is made of a lead core with metal envelope, and has, like the 6·5 mm. (0·2569 in.) Mannlicher bullet, a length of 5 calibres (0·985 in.), it will only weigh 5 gm. (77·162 gr.); if, on the other hand, it is given the same weight, 10·5 gm. (162 gr.), a length of about 11 calibres (2·167 in.) is reached.

[1] Captain Weigner, Attaché to the Vienna Military Committee, is of the same opinion. In giving in the "Mittheilungen" (No. 5) the Austrian experiments detailed above, he observes that the boring and rifling of a 5 mm. (0·197 in.) barrel does not, nowadays, present serious difficulties, even with a length of barrel of 70 mm. (27·56 in.) or more. Besides, he adds, nothing prevents the reduction in the length now recognized; for one reason, the condition of being able to fire in two ranks will no longer have any *raison d'être*; for another, the complete utilization of the ballistics of the new powders properly chosen, does not require nearly such long barrels.

NAVAL AND MILITARY NOTES.

NAVAL.

Home.—The "Howe" still remains on the rocks, and although towards the end of last month the hopes of salving her had much diminished, the latest telegrams are much more favourable. The ship is reported to have righted up to 11°, while her bows have lifted enough to permit the passing of hawsers under the ship for the purpose of fixing the collision sheets. The divers report that all the bottom under the starboard stokeholds and engine-room is badly pierced, but steps can now be taken to remove the rocks by blasting, as was done on the port side. The forward part of the ship has been pumped nearly dry.

The "Collingwood" has returned to Portsmouth from the Mediterranean, been paid off, re-commissioned by Captain A. B. Jenkings, and has again left for her former station. The "Royal Arthur" was commissioned, on the 2nd inst., as flagship for the Pacific, by Captain Trench, and will fly the flag of Rear-Admiral Stephenson, C.B.; the "Edgar" was also commissioned on the same day by Captain Acland to relieve the "Undaunted" in the Mediterranean. The "Achilles" takes out the new crew for the "Victoria," the flagship in the Mediterranean.

The "Hood," the second of the new first-class battle-ships built under the Naval Defence Act, to be completed for sea, has successfully undergone her steam and gunnery trials off the Nore. During a seven hours' run under natural draught, with steam at 150 lbs. pressure per sq. in., vacuum 28 in., air pressure in stoke-holds 0·44 in., and the engines making a mean of 95 revolutions per minute, the engines developed a mean I.H.P. of 9,540, an excess of 540 over the stipulated contract power, while the mean speed by log was 15·8 knots. At the four hours' forced draught trial, with steam at 155 lbs. pressure per sq. in., vacuum 28 in., air-pressure in stoke-holds 1 in., and a mean of 101 revolutions of engines per minute, the mean I.H.P. realized was 11,445, which gave the ship a speed of 17 knots. The "Hood," like her sisters, is 380 ft. long between the perpendiculars, has a moulded breadth of 75 ft., and a displacement at load draught of 14,150 tons; unlike the other seven, however, she carries her four 67-ton guns in turrets, instead of their being mounted in barbettes. At the trials, her draught was 25 ft. 6 in. forward, and 27 ft. 4 in. aft, giving a mean of 26 ft. 5 in., at which her propellers are immersed 9 ft.

The armoured ram "Rupert" has also completed her steam and gun trials at Portsmouth, after having undergone a thorough refit, which included new engines and boilers and a modern armament. This vessel, which has a displacement of 5,440 tons and is protected by iron plating 11 in. in thickness, was launched at Chatham as far back as March, 1872. She was designed by Sir Edward Reed during the administration of Sir Spencer Robinson as Controller of the Navy, and, though carrying two heavy guns in her single turret, she was constructed with the purpose of enabling her to use her ram as the most important feature in her powers of attack. She was accordingly provided with a special bow and bow strengthenings. Her former armament, which had undergone some slight modifications since her first commission, consisted of a pair of 18-ton muzzle-loaders, two 6 in. breech-loaders, and some smaller guns. The new armament consists of two 9·2-in. 22-ton breech-loaders, two 6-in. breech-loaders, five 6-pr. Q.F. guns carried on the superstructure, and the same number of smaller guns. The "Rupert" was originally

fitted with twin-screw, horizontal, direct-acting, simple surface condensing engines, by Messrs. Napier and Sons, and they developed on trial I.H.P. of about 4,600, the speed of the ship being 13·5 knots. She has now been furnished with twin-screw, vertical, triple-expansion engines, designed, manufactured, and fitted in the ship entirely by the dockyard engineer department. They are designed to indicate 4,500 H.P. under natural draught, and 6,000 H.P. under a forced draught equal to 1 in. of water pressure. In other words, they are the largest set hitherto built at Portsmouth, and are as yet the only engines which have been constructed in a Royal dockyard for an armour-clad. The principal features of the machinery are as follows:—Diameter of cylinders—high 31½ in., intermediate 46 in., low 69 in.; length of stroke, 3 ft. 3 in.; boiler pressure, 145 lbs.; diameter of boilers, 14 ft.; total of furnaces, 18. The high-pressure and intermediate slide-valves are of the piston type, the low-pressure valves being flat and double-ported. These are actuated by ordinary link motion. Steam is provided by four boilers—two double-ended six-furnace, and the others single-ended three-furnace, boilers. The latter are placed together, and are equal to one double-ended boiler. The combustion chambers are so arranged in the double-ended boilers that each of the opposite pairs of furnaces has a common combustion chamber, while the single-ended boilers are fitted with a common combustion chamber to the three furnaces. These boilers were made at the Portsmouth yard, and, during construction, were fitted with the Admiralty-type tube ferrules, which have enabled forced draught to be successfully applied to boilers in Her Majesty's service that had previously failed under this condition. The steam trials comprised a run of eight hours with natural draught, and four hours with forced draught. The results of the trials were as follows:—

	Natural draught.	Forced draught.
Draught of water	20 ft. 2 in.	19 ft. 9 in.
Steam in boilers	131 lbs.	131 lbs.
Vacuum	28·8 in. and 28 in.	28 in. and 27 in.
Revolutions	105¼	111·68
Total I.H.P.	2483·2 and 2374·3	3019·1 and 3006·4
Collective I.H.P.	4857·65	6015·61
Mean air pressure	0·35 in.	1 in.
Speed of ship	13·75 knots.	14·4 knots.

The trials proved eminently satisfactory, not a hitch occurring from first to last. The effect of the re-engining has been to increase the speed of the ship, on an emergency, by a knot over her former speed, while it is now assured that she can maintain a sea-going speed equal to her previous trial speed. The economy of fuel consequent on the substitution of triple expansion engines for her old engines is also an important advantage, and she is undoubtedly now a far more formidable and efficient ship than she was before.

The "Grafton," one of the nine 1st Class protected cruisers authorized under the Naval Defence Act, has just been completed by the Thames Ironworks Company, at Blackwall, and handed over to the dockyard authorities at Chatham. Save for her guns and torpedo-tubes, she is practically in a condition for going to sea. The ship is 360 ft. long, and 60 ft. beam, and, at her load displacement of 7,350 tons, will have a mean draught of about 23 ft. 9 in. All her vitals are protected by means of a steel deck, varying in thickness from 2 in. on the summit to 5 in. on the slopes, and 5-in. armoured inclined coamings, backed with teak, which protect such portions of the twin triple-expansion engines as rise above the steel deck. These engines will indicate 12,000 H.P., giving a speed of about 19·7 knots. The coal capacity is sufficient to afford a radius of action of about 10,000 miles, while the ship maintains her most economical speed. The armament will consist

of two 9·2-in. B.L. guns, one forward and one aft, ten 6-in. Q.F. guns on the broadsides, sixteen smaller Q.F. guns, and four torpedo-ejectors, two of which are submerged, for the new 18-in. Whiteheads. The engines are by Messrs. Humphrys, Tennant, and Co.; the armour partly by Messrs. Cammell and partly by Messrs. Vickers, the latter firm supplying the plates for the splinter-proof casemates, in which the broadside guns are mounted, and which almost exactly resemble the casemates for the 6-in. guns in the battle-ships of the "Royal Sovereign" class. The "Grafton," it is worth while to point out, inherits a name which was first given to an English war-ship in honour of that gallant natural son of Charles II, who not only commanded her at the battle of Beachy Head, but also had his pennant flying in her when, leading a party on shore at the storming of Cork, he was mortally wounded by a musket ball, in 1690. The "Grafton" afterwards served at the battles of La Hogue in 1692, at the capture of Gibraltar in 1704, and in Rooke's victory over the French in the same year. In 1718 she took part in Byng's victory over the Spanish off Messina, and in 1759 in the action of Admiral Pocock with the French. Another "Grafton" took part in Byron's action with the French in 1779, and in Rodney's victory over the Spanish off Cape St. Vincent in 1780, and with such an honourable record attached to the name, the officers and men who may be appointed to the new "Grafton" may well feel proud.

On January 31 was launched, at Pembroke Dockyard, the "Cambrian," one of the twenty-nine 2nd Class cruisers for which provision was made in the Naval Defence Act; she is, however, one of the eight cruisers modified from the "Apollo" or "Latona," the original type of the class. The others of the improved type are the "Astræa," "Bonaventura" (already launched), "Charybdis," "Flora," "Fox," "Forte," and "Hermione." These vessels are all under construction; they are 25 ft. longer, and of 4,360 tons displacement, or about 760 tons heavier than their predecessors, which gives them better accommodation, and enables them to carry their armament higher out of water. The "Cambrian" is 325 ft. long, with a beam of 49 ft. 6 in. When completed for sea, her mean draught will be 19 ft.; her upper deck will be 14 ft. 3 in., and the centre of her midship guns 18 ft. above the water line. She is wood-sheathed to the height of about 1 ft. above the water line.

The Admiralty have decided to add another class of gunboats to the navy, and in the new Estimates provision will be made for thirteen of them, all of which are to be built by contract. The new vessels are to be termed torpedo-boat destroyers, and in size they will be between a torpedo-catcher of the "Sharpshooter" class and a 1st Class torpedo-boat. The new boats should prove a valuable addition to the navy, especially if, as is expected, they realize a high rate of speed. Their armament is to consist of one 12-pr. and three 6-pr. Q.F. guns, in addition to which they will be supplied with five 18-in. torpedoes for use in a bow-tube, and two revolving tubes amidships.

A second experimental armour plate, manufactured according to the Harvey system of hardening, was tested at the latter end of January on board the "Nettle," at Portsmouth. The plate was of the usual standard superficial dimensions, but was only 6 in. in thickness, or 4 in. thinner than the one previously fired at. The ordeal to which it was subjected was substantially the same that is ordinarily enforced, the 6-in. breech-loader, with Holtzer projectiles weighing 100 lbs., being used at a range of 10 yards. In view, however, of the comparative lightness of the target, it was deemed advisable to reach the "maximum" powder charge by graduated rounds. The trial was private, but it is understood that the results were as follows:—A 30-lb. charge inflicted no damage; a projectile fired with a 42-lb. charge also failed to penetrate; but a Holtzer discharged with 48 lbs. of powder, the highest amount allotted to the gun, penetrated the face and part of the backing, but without disintegrating the armour, which was again fired at with a "maximum" charge.

Nickel Steel for Shipbuilding.—Mr. Peter Imrie, of Halifax, has stated in the "Economist" that an addition of from 3 to 5 per cent. of nickel not only doubles

the strength of the steel, but also protects it from rust and corrosion, as well as fouling in sea water; as a consequence he concludes that ships constructed with nickel steel would not require frequent docking, while on account of the increased strength their weight could be reduced, with a corresponding saving in coal consumption. According to Mr. Imrie, it will not be long before nickel steel for shipbuilding will have driven all other material from the field, and as this would cause an enormous demand for nickel, the prospects are bright for Canada, as she possesses an unlimited supply of nickel-bearing pyrites, and in the opinion of experts is in a position to put into the market for an unlimited time 1,000 tons yearly. An Austrian journal remarks on this, that nickel steel undoubtedly has an important part to play in future industry, but that it will owe its importance more to its quality of toughness and security against rupture than to its absolute strength For this reason the hull of a ship constructed with nickel steel plates would not be so easily broken when the ship took the ground, or when otherwise subjected to similar rough usage; but the material would have no advantage over ordinary steel in resisting the constant strains set up by the working of the ship in a seaway, as in such conditions the elasticity of the metal is the most important factor, and the elastic limit of the nickel steel is no higher than that of ordinary steel, especially when annealed ("Marine Engineer," and "Mittheilungen").

Petroleum in Solid Form as Fuel.—In spite of numerous efforts, the employment of petroleum as fuel has only met with comparative success in those districts where petroleum springs are common; lately, however, many of the disadvantages which have stood in the way of its more general employment have been overcome by successful experiments which have been carried out with a view of employing it in a solid form. This result is the invention of Mr. Chenhall, who has disposed of his rights to a company formed to work it, in Westminster. The unrefined petroleum is first mixed with 15 per cent. by weight of a certain highly inflammable substance, and the vessel with the mixture is left for a short time standing in boiling water, so that an intimate combination of the two substances takes place. The vessel containing this mixture is then placed in an oven, and the contents brought to a temperature of from 390° to 500° Fah., which is maintained until the mass has become thickened to the consistency of stiff clay or dough; in this state the material is moulded to the required form, and after it has cooled is fit for use. The process is not an expensive one, as can be perceived from the above description, and occupies only about half an hour for the complete operation; the heating effect of the petroleum is not impaired, and the ash remaining after combustion does not exceed 1 per cent. ("Rivista di Artigleria e Genio").

Foreign, in general.—In our last month's notes we gave a list of ships launched for the English navy during the year 1892. The following is a list of foreign warships launched during the same period:—

France.—The coast-defence ironclads "Bouvines," "Jemmapes," and "Valmy," each of 6,800 tons and 8,400 I.H.P.; the armoured cruiser "Latouche-Tréville," of 4,745 tons and 9,370 I.H.P.; the torpilleurs-de-haute-mer "Chevalier," "Dragon," "Grenadier," and "Tourbillon"; the submarine-boat "Gustave Zédé," and a number of first-class torpedo-boats.

Germany.—The battle-ship "Woerth," of 10,300 tons and 9,500 I.H.P.; the coast-defence ironclads "Heimdal" and "Hildebrand," each of 3,600 tons and 4,800 I.H.P.; the protected cruiser "Kaiserin Augusta," of 6,052 tons and 12,000 I.H.P.; the cruiser "Cormoran," of 1,880 tons and 2,700 I.H.P.; the torpedo cruisers "See Adler" and "Kondor," of 1,600 tons and 2,700 I.H.P.; the Imperial yacht and armed dispatch vessel "Hohenzollern," of 3,400 tons and 10,000 I.H.P.; and eight torpedo-boats.

Austria-Hungary.—The torpedo depôt ship "Pelikan" of 2,240 tons and 4,700 I.H.P.; the torpedo-gunboat "Satellit," of 500 tons and 4,600 I.H.P., and a torpedo-boat.

Italy.—The protected cruisers "Marco Polo," of 4,583 tons and 10,000 I.H.P.; "Cristoforo Columbo," of 2,466 tons and 3,800 I.H.P.; and "Minerva," of 840 tons and 4,800 I.H.P.; and the special service vessels "Atlante" and "Ercole," of

775 tons and 1,200 I.H.P.; together with several torpedo-boats and the submarine-boats "Pullino" and "Audace."

Russia.—The battle-ships "Georgei Pobiedonosets," of 10,280 tons and 10,600 I.H.P., and "Tri Swjatitelja," of 12,000 tons and 10,600 I.H.P.; the armoured cruiser "Rurik," of 10,900 tons and 13,000 I.H.P.; the armoured gunboats "Gremjaseiji" and "Otvaznji," each of 1,490 tons and 2,000 I.H.P.; the torpedo-gunboat "Vojevoda," of 400 tons and 3,600 I.H.P.; and the torpedo-boat "Pernow," and three or four others.

Denmark.—The protected corvette "Geiser," of 1,270 tons and 3,000 I.H.P.; a mine vessel, the "Hjälperen," of 250 tons, and a torpedo-boat.

Sweden.—The coast-defence ironclad "Thule," of 3,086 tons and 3,100 I.H.P.

Holland.—The ironclad "Konigin Wilhelmina," of 4,580 tons and 6,000 I.H.P.; the gunboat "Borneo," of 817 tons, and several torpedo-boats.

Spain.—The armoured cruiser "Imperador Carlos V," of 9,235 tons and 15,000 I.H.P.; and three torpedo-gun-vessels.

Portugal.—One small torpedo-boat.

Turkey.—The corvette "Lufti Humayoun," of 1,310 tons and 2,000 I.H.P.; the torpedo-gun-vessel "Shahin Deria," of 450 tons; and several torpedo-boats.

United States.—The battle-ship "Texas," of 6,300 tons and 8,600 I.H.P.; the cruisers "Columbia," of 7,350 tons and 21,000 I.H.P.; the "Olympia," of 5,500 tons and 13,500 I.H.P.; the "Raleigh" and "Cincinnati," each of 3,180 tons and 10,000 I.H.P.; the "Montgomery" and "Marble Head," each of 2,000 tons and 5,400 I.H.P.; the "Bancroft," of 800 tons; the gunboats "Castine" and "Machias," of 1,050 tons and 1,600 I.H.P.; and the special service vessels "Iwana," "Narkeeta," and "Wahneta."

Brazil.—The protected cruiser "Republica," of 1,300 tons and 3,300 I.H.P.; the gunboat "Tiradentes," of 800 tons and 1,200 I.H.P.; the training cruiser "Benjamin Constant," of 2,750 tons and 2,800 I.H.P.; and three small gunboats for river service.

Argentine Republic.—The protected cruiser "Nuevo de Julio," of 3,650 tons and 14,500 I.H.P.

Japan.—The protected cruisers "Yoshino," of 4,150 tons and 15,000 I.H.P.; and "Akitsushima," of 3,150 tons and 8,400 I.H.P.

Siam.—The yacht cruiser "Maha Chakri," of 2,500 tons.

Liberia.—The gunboat "Gorronomah."

Building activity during the year was particularly noticeable in the dockyards of the United States, where several very large and powerful vessels are still upon the stocks.

Argentine Republic.—In spite of financial difficulties, money still continues to be found for adding considerably to the Argentine fleet. Two remarkable little ironclads, the "Libertad" and the "Independencia" have lately been built by Messrs. Laird Brothers, at Birkenhead, for this Government, which are worthy of more than a mere passing notice. Being both of the same type, a description of the "Libertad," which, having most satisfactorily undergone her steam and gunnery trials, sailed in January for South Africa, will suffice: the "Independencia" is not yet completed. The problem which was presented to the builders by the Argentine Naval Commission was the construction of a heavily-armed and well-armoured steel ram, of fairly good speed, of light draught, and of the smallest possible displacement; and the manner in which, thanks to the ingenuity of Messrs. Laird and of their naval architect, Mr. Siemens, the various difficulties have been met, is remarkable; for, in response to the demand, there has been created a type of vessel which can, with all bunkers filled, carry 340 tons of coal; which has 8-in. compound belt armour along two-thirds of her length; has substantial athwartships bulkheads, one with 8-in. armour forward and the other with 6-in. armour aft; has an over-all protective deck, a partial double bottom, and over forty separate water-tight compartments; two barbettes, with armour varying from 5 in. to 8 in. in thickness, surmounted by steel shields of 5-in. plates; twin-screws driven by compound engines of 3,000 H.P.; has steamed for four hours at a mean speed, in a heavy swell, of 14·21 knots;

has a radius of action of over 3,000 knots, and which nevertheless draws only 13 ft. of water with a displacement of only 2,300 tons. The armour belt is about 5 ft. wide, and its upper edge is about 2 ft. above the water line; behind is a teak backing of 9 in., secured to the inner skin of steel 1 in. thick. The engine room and stoke holes are divided by a centre line longitudinal bulkhead and three transverse bulkheads extending from the floor to the upper deck. The magazines are situated below the protective deck, immediately under the barbettes, a tube rising from each through which the ammunition is passed. The hoisting gear is under the protective deck; this deck extends the whole length of the ship, being joined to the upper edge of the armour belt, beyond the extremities of which it slopes away to the ends and sides and is here 2 in. thick, the fore end extending to the ram for which it forms a support. The armament of the ship consists of two 9·37 Krupp guns, one in each barbette, four Elswick 4·7 Q.F. guns, with shielded mounts, two 1-in. Nordenfelts, two machine-guns, and four 3-pr. Nordenfelt Q.F. guns; she is provided, in addition, with two torpedo-ejectors for the latest pattern 18-in. Whiteheads, has two search lights, is lighted throughout with the electric light, and is fitted with all the most recent improvements. The general design is that of a greatly reduced "Barfleur," 230 ft. long on the water line and 44·4 ft. beam, with a freeboard of 9·6 ft. There are a flush upper deck without bulwarks, a central breastwork, above which are stowed the boats, a 4-in. conning-tower, and a single military mast with two tops, in the upper of which are mounted two 1-pr. Q.F. guns, and in the lower a search light is fitted. The heavy guns, which, though by Krupp, are on the latest Elswick high-angle fire mountings, can be raised by the hand of a single man from their extreme depression to their maximum elevation of 40° in about twenty-five seconds, and everything connected with them can be worked by manual labour, and the arrangements for hoisting up powder and projectiles and for the loading by pneumatic machinery are excellent and well protected. The ship is roomy and the officers' quarters are even spacious. At her official trials, the "Libertad," with natural draught and an air pressure not exceeding ½ in., made a mean speed of 13·35 knots for four hours, and with moderate forced draught, the air pressure being 1·05 in., a mean speed of 14·21 knots for the same period. The gun trials were particularly interesting, on account of the high angles at which the ship's heavy guns were fired. Each of her Krupp guns weighs 21·5 tons, and, with a full charge of 187 lbs. of brown prism. powder, throws a projectile of 352 lbs., with a muzzle velocity of 2,133 foot-seconds and a muzzle energy of 11,105 foot-tons; each trains over an arc of 260°, and has a vertical range of 45°, *i.e.*, 40° of elevation and 5° of depression. The heavy guns were fired on the beam, 45° before and abaft the beam and with 25° elevation. Full charges and common shells were used. After the firing, no sign of strain or weakness, in either the mountings of the guns or the structure of the ship, could be detected, and this, in spite of the fact that the axes of the guns, when horizontal, are only 5 ft. above the "Libertad's" deck. The noteworthy feature of the trials was the complete success of the Elswick high-angle mounting.

In addition to the "Libertad" and "Independencia," the trials of a new cruiser, the "Nuevo de Julio," for the same Government, but built at Elswick by Sir W. Armstrong and Co., have just been most successfully completed. She is the second vessel of the class built by that firm for the Argentine navy, but is somewhat larger than her predecessor, the "25th de Mayo," which left for South America in the end of 1891. The principal dimensions of the "Nuevo de Julio" are:—Length, 354 ft.; beam, 44 ft.; depth of hold, 26 ft.; and displacement, 3,570 tons. At natural draught, during a run of six hours, she realized a mean speed of 21·9 knots, and under a moderate forced draught, she attained the high speed of 22·74 knots (the mean of six runs on the measured mile), which was maintained for two hours. The engines are by Messrs. Humphrys, Tennant, and Co., and needless to say worked splendidly during the whole trial. There was no perceptible vibration while proceeding under natural draught, and but little under forced draught, while owing to her fine lines, the wave thrown off from her bows, even at the highest speed, was inappreciable. The I.H.P. reached 13,000 under natural and 14,500 under forced draught. The vessel has a very large range of

action, stowing 350 tons of coal as her normal supply, but being capable of carrying a further 420 tons in reserve bunkers. For armament, the "Nuevo de Julio" carries four 6-in. Q.F. guns (three of which can fire right ahead and one right astern), eight 4·7-in. Q.F. guns, twelve 3-pr. Hotchkiss guns, and twelve 1-pr. Hotchkiss guns. She is also provided with five tubes for discharging the latest pattern 18-in. Whitehead torpedoes.

Austria-Hungary.—The torpedo-cruiser "Satellit" has recently made a very successful trial under forced draught at Pillau. The wind was high at the time, and the trial took place in a snowstorm, but a speed of 21·8 knots was reached, which it was considered under more favourable circumstances would have been increased to 22·5 knots, or half-a-knot more than the contract speed. During the trial the cruiser was fully prepared for sea, and carried two-thirds of her full complement of coal in her bunkers. She has been built in the Schickau yard, and is about to proceed to Pola. She is 220 ft. 6 in. long, with a beam of 26 ft. 10 in., and her engines develop 4,600 H.P.

France.—The whole of the French shipbuilding programme for 1892 was put in hand by the end of the year. It included the battle-ship "Massena," 11,730 tons, and 12,600 I.H.P.; the battle-ship "Bouvet," 12,205 tons and 14,000 I.H.P.; both these ships will have three screws driven by independent engines; the armoured cruiser "Pothuau," of the same type as the "Latouche-Tréville," but larger, viz., 5,320 tons and 10,000 I.H.P.; the 2nd class protected cruisers "Descartes" and "Pascal," both of 3,888 tons and 9,000 I.H.P., to give a sea speed of 19 knots; the 3rd class cruisers "Galilée" and "Linois," enlarged "Surcoufs," the one 2,317 tons and 6,500 I.H.P., the other 2,270 tons and 6,600 I.H.P.; the torpedo-catcher "Cassini," 943 tons and 5,900 I.H.P.; the cruiser-torpedo transport "Foudre," 5,970 tons and 11,400 I.H.P.; and the submarine boat "Morse," whose tonnage will be larger than that of the "Gymnote," but smaller than that of the "Gustave-Zédé." The list of ships launched during 1892 has been already given. The following ships are either completed or are still undergoing their trials; the battle-ship "Magenta," 17 knots, of 10,580 tons and 12,000 I.H.P. (she is the last ship of the programme of 1880); the "Neptune," of the same type as the "Magenta," 16·2 knots, with 11,045 I.H.P.; the armoured cruiser "Dupuy-de-Lôme," of 6,300 tons and 14,000 I.H.P., commenced her trials, but they had to be deferred in consequence of an accident to one of her boilers; the 1st class cruiser "Alger," 19·6 knots, of 4,120 tons and 8,254 I.H.P.; the 2nd class cruiser "Davout," 20·07 knots, of 3,027 tons and 8,880 I.H.P.; the torpedo-cruiser "Wattignies," 18·6 knots, of 1,310 tons and 4,189 I.H.P.; the "aviso-torpilleurs" "Léger" and "Lévrier," 18·5 knots, of 440 tons and 2,345 I.H.P.; eleven "torpilleurs-de-haute-mer," from 104 to 125 tons; four of the 1st class of 80 tons, and three of the 2nd class of 50 tons, have also been completed; of the "torpilleurs-de-haute-mer," the "Véloce" attained a speed of 22·7 knots; the "Normand" 24·51 knots, the "Dragon" 25·05 knots, and the "Grenadier" 24·86 knots. The 1st class cruiser "Isly," a sister ship to the "Alger," commenced, but has not yet completed, her trials.

The vessels expected to begin or complete their trials in 1893 are: the battle-ship "Brennus," of 12,000 tons, 13,500 estimated I.H.P., and an estimated speed of 19 knots; the armoured cruiser "Charner," of 4,750 tons, 9,370 I.H.P., and an estimated speed of 19 knots; the 1st class cruiser "Isly," 4,160 tons, 8,000 I.H.P., and estimated speed of 19 knots: the torpedo-catcher "Fleurus," 1,310 tons, 4,000 I.H.P., and 18 knots: the coast defence battle-ships "Jemmapes," 6,590 tons, 8,400 I.H.P., and 17 knots; the armour-belted cruiser "Latouche-Tréville," 4,700 tons, 9,370 I.H.P., and 19 knots; the torpedo-dispatch vessel "D'Iberville," 925 tons, 5,000 I.H.P., and 21 knots; the "torpilleurs-de-haute-mer" "Archer," "Chevalier," "Corsaire," "Tourmente," "Averne," "Lansquenet," "Tourbillon," and "Sarrazin," and the 1st class boats 145, 146, 153 to 160, and 170 to 182.

The new constructions included in the "projet" of the French Budget for 1893 are as follows: Two 1st class cruisers, "N" and "O," of 7,600 tons, 13,400 I.H.P., and 19 knots, with two guns of 9·4 in., eight Q.F. of 5·5 in., ten of 1·85 in., and six of 1·45 in., which nearly resemble our "Edgar" type; three 2nd class cruisers, "P," "Q," and "K;" one of the 3rd class, "L;" a torpedo-catcher, "R," which is to have a speed of from 21 to 22 knots; seven "torpilleurs-de-haute-mer," lettered from "T" to "Z," of which, in the case of four, a speed of 23·5 knots only is required; and nine 1st class torpedo-boats, numbered from 192 to 200. The total estimate for these vessels, of which it is proposed to construct only the cruisers "K" and "L" in the dockyards, is 70,921,000 francs, of which 20,879,250 francs are to be asked for the year 1893. In addition there is to be put in hand a gunboat armed with Q.F. guns, which is proposed to have a speed of only 13 knots, and the cost of which (1,307,000 francs) was included in the supplementary estimates of 1892. According to the report of M. Thomson on the French Marine Budget, the guns now under construction for the French Navy are as follows:—At Ruelle, of steel, 1 of 16·54 in., 15 of 13·39 in., 12 of 11·81 in., 7 of 10·79 in., 10 of 7·64 in., 62 of 6·49-in. Q.F., 1 of 6·49 in., of the hitherto unheard-of length of 90 calibres, 168 of 5·46 in. Q.F., 77 of 3·93 in. Q.F., and 8 of 2·57 in. Q.F.; cast guns, 10 of 12·6 in., 1 of 11·81 in., 6 of 10·79 in., and 9 of 9·45 in. At Havre, 29 of 3·94-in. Q.F. (Canet), 24 of 3·94 in. Q.F. (Canet-Ruelle), and 6 of 6·3 in. Q.F. (Canet-Ruelle). In addition, 8 of 5·5 in. Q.F. at Havre, and 8 of 5·51 in. Q.F. at Creusot are upon the point of being ordered. These arrangements will give to the French navy three different systems of breech action, namely, the Naval, the Canet, and the Creusot. Of smaller Q.F. guns, 49 of 2·57 in., and 200 of 1·84 in. and 1·4 in. are being completed. In all, therefore, 709 guns are to be built. The experiments with the Maxim 1·4-in. automatic gun have given such results that it is expected that a few specimens of this weapon will now be ordered to be supplied to ships.

Not long ago an interesting trial took place at Brest, which had for its purpose to determine if the explosion of a torpedo, charged with 80 kilos. of guncotton, beneath the hull of a vessel would cause the explosion of the ammunition within. The old dispatch-boat "Cuvier" was towed out, her internal arrangements having been made to resemble those in a modern man-of-war. When the destructive charge was exploded, an immense body of water was thrown up, and the "Cuvier" at once went down by the bows, fragments of wood being thrown to a distance of some 500 yards. In effect, it was found upon exploration that, although the "Cuvier" had been effectively torpedoed, the guncotton within her, which represented Whitehead charges, remained intact. This was what the experiment was intended to elucidate.

That we are not the only country where new ships do not always prove as successful as their designers expected, is shown by the reports received of the 1st Class cruiser "Jean Bart;" this cruiser, a vessel of 4,160 tons, 8,000 I.H.P., and a forced draught speed of 19 knots, was completed a year ago, and commissioned to join the active division of the Toulon fleet. It has been discovered that considerable structural weakness exists, and that the gun-deck is not strong enough to support the strain of the weight and firing of her armament. According to present arrangements, she is to return to Rochefort in March, at which port she was built, and the necessary work of strengthening her decks and upper works will be taken in hand. The battle-ship "Hoche," flag-ship of Rear-Admiral Dorlodot des Essarts, seems to be proving herself anything but a good sea boat. When *en route* to Toulon at Christmas, a head wind and choppy sea were experienced, and it is reported that she shipped such quantities of water over her bows that the lower decks were flooded and some of her furnaces extinguished, while the pumps had to be kept at work for some hours; it is further reported, that when lying with the squadron on the night of January 11, in Saint Tropez roads, she was struck by a squall about 2 o'clock in the morning, and heeled over to port to such an extent that the ship at one time was considered in actual danger. The guns were trained to starboard, and every effort made to right her, the pumps being kept ready, as she took in a

good deal of water; towards daybreak the wind fell and the ship righted. The "Hoche" has a lofty superstructure which presents a large holding surface to the wind, while her small amount of freeboard forward and the lowness of her hawse-holes, through which she took in an immense volume of water, combined to create a situation which was for a time decidedly alarming; it is now tolerably certain that no more French men-of-war will be built with beach bows or *avants à plage*.

An experiment of firing at cases filled with petroleum took place not long ago at sea, near Toulon. This experiment had for its object to ascertain whether this mineral oil, which it is proposed to use in torpedo-boats as fuel, would not be dangerous. Ten cases filled with petroleum, protected by a sheet of iron or metal plates similar to the sides of a torpedo-boat, were placed on a raft, and a 3-pr. quick-firing gun, placed on a floating pontoon moored 100 yds. away, fired twelve shots at the plate, the result being that eight of the cases are said to have been ignited; there appears, however, to be some doubt as to the ignition, and we await further information on this point. Owing to the high price of petroleum in France, it is not at present, in any case, contemplated to use liquid fuel only, but to employ it in combination with coal. It will not replace forced draught, but is expected to be a valuable auxiliary, which will enable a high speed to be obtained at any time, and to be kept up for an indefinite period. At Cherbourg, a cylindrical, direct-flame boiler was experimented with, and it was found that the increase of boiler power was 24 per cent., the most advantageous proportion of petroleum to be employed, injected as a spray, being 15 per cent. At Toulon the experiments were exhaustive, and it was found that 34 per cent. of petroleum gave a power almost equivalent to forced draught, but it is to be noticed that the forced draught of the "Papin," in which the trials were conducted, is very moderate (the "Papin" is a small dispatch-vessel of 810 tons and 855 I.H.P.). From both sets of experiments the conclusion is, that the use of from 15 to 20 per cent. of petroleum will give an accession of power of from 20 to 22 per cent. An installation of petroleum apparatus will therefore be made in two 3rd Class cruisers of the "Forbin" type, and in two torpedo-cruisers of the "Vautour" type; and, at the same time, trials are to be made on board a torpedo-boat of a system of petroleum stoking and storage, devised by M. Ferrari, who is said to demand the sum of 1,200,000 francs for the exclusive rights in his invention. M. Weyl is of opinion that the experiment of igniting liquid fuel by shell fire at Toulon was not conclusive against its employment in the navy. According to him, the advantage of the liquid fuel spray is so great for increasing speed without having recourse to forced draught, as well as by reason of its smokeless consumption, and the ease with which the heavy oils are stored and supplied, that if the risk of ignition can be shown to be small and the advantages of the system outweigh its inconveniences, the French navy will not hesitate to introduce this liquid stoking in combination with the use of coal, even on board torpedo-boats. In large ships the oil would be in a safe position if stored in a part of the double bottom, and the explosion of a shell in the liquid substance would be an occurrence of great rarity. There is no information as to what kind of petroleum was experimented with at Toulon, nor as to the natural degree of inflammability of the oil.

A mobilization experiment has been carried out with the "Normandie" auxiliary cruiser with highly satisfactory results. The ship discharged all material not required on board in her new character at Havre, had ports cut and gun platforms fitted and other internal modifications made, and then proceeded to Cherbourg, where she took on board two forward and one aft central-pivot 5½-in. guns, four broadside 5½-in. and eight 1·4-in. Hotchkiss guns, with three rounds of ammunition for each of the 5½-in., and twenty rounds for each Hotchkiss gun, and some reserve stores. The naval complement embarked consisted of 1 Lieutenant, 1 Sub-Lieutenant, 1 gunner 1st class, 3 3rd class, 15 trained men for guns' crews, 8 riflemen, and 40 seamen; the command of the ship remained in the hands of her own Captain. The "Normandie" thus fitted out went through her steam and gun trials very satisfactorily, and it would appear that the entire work of mobilization was very care-

fully carried out. All the other auxiliary cruisers will receive a similar armament to that of the "Normandie."

It is announced that all the auxiliary cruisers will be assigned to the ports of Havre, Bordeaux, and Marseilles, and all the necessary war material for them will be kept in magazines specially provided for the purpose. On receipt of orders for mobilization the cruisers will repair to their respective ports and complete with everything except guns and ammunition; for supply of the latter, the Havre ships will repair to Cherbourg, the Bordeaux ships to Rochefort, and the Marseilles ships to Toulon.

The conversion of the 10-, 14-, and 16-cm. guns into Q.F. guns is proceeding rapidly, and the following ships will shortly be either partly or completely armed with these guns., viz., "Magenta," "A. Baudin," "Marceau," "Hoche," "Brennus," "Formidable," "Courbet," "A. Duperré," "Dévastation," "Dupuy de Lôme," "Latouche Tréville," "Charner," "Alger," "Isly," "Jean Bart," "Cécille," "Sfax," "Tage," "Forbin," "Surcouf," "Troude," "Davout," "Cosmao," "Condor," "Fleurus," "Achéron," "Styx." In the meantime the manufacture of new guns of these calibres is being proceeded with at the works of Messrs. Canet and Creusot, but none of these new guns of 1891 model are yet in the service. ("Riv. Marittima.")

A New Oil Paint.—Five litres of "cotton" oil are put into a metal vessel, and 10 kilos. of lead, which have been melted in another vessel at a temperature of 640° Fah. are poured into the oil as slowly as possible, the oil at the same time being briskly stirred, so that the two substances are brought into intimate contact. As soon as the oil is cooled down it is drawn off, and it is then found that only about 8½ kilos. of lead remain, from which it follows that the oil has absorbed 1½ kilos. of the metal. By repeating the process it is found that after the 5th operation only 5 kilos. of lead remain, the oil having absorbed the other 5 kilos., which is the full amount that it is able to take up. The liquid so obtained has the appearance of a kind of varnish, and can be applied to the surface it is desired to protect by means of a sponge or brush. It adheres exceedingly well to all sorts of material; the first coat, however, must be allowed forty-eight hours to dry before the second is applied. The inventor of this paint remarks that a special quality of olive and similar vegetable oils is their power to absorb a large amount of lead, and he believes the same absorbing power probably extends to other metals. The paint here described is especially suitable for protecting metal surfaces, such as ironwork on board ships which are subject to spray from sea water; it also forms a good protective for woodwork, and can be used with advantage for bridges, &c., both in sea and fresh water ("Le Génie Civil").

Preservation of Water Tube Boilers.—It has been directed that these boilers when not in use are to be kept filled with water neutralized by means of lime or soda, and the tubes painted externally with red lead, or coated with coal tar; where this is not possible they are to be preserved by burning mineral tar under them so that the products of combustion will be condensed and deposited on the cold surface of the tubes and so form a protective covering against corrosion.

Examination of Condensers.—It has also been directed that in all machinery under construction, and as soon as opportunity offers also in all machinery in the service, doors are to be fitted to the condensers, so arranged that the point of attachment of the tubes to the tube plates can be reached by the hand. ("Riv. Marittima.")

The French navy has experienced a great loss by the sudden death, on February 17, on board his flag-ship, the "Dévastation," of Rear-Admiral Buge, who commanded the 3rd, or Levant, Division of the active Mediterranean fleet. The deceased naval officer was interred at Nice, on the 17th, with full honours.

Germany.—The "Komet," which was launched in November last, is similar to the "Meteor;" length 230 ft.; beam 30 ft.; draught of water 8 ft.; displacement, 975 tons, with engines of 5,000 H.P., designed to give her a speed of 21 knots. The protective deck is from ⅝ in. to 1 in. in thickness, the armament consists of four 3½-in. quick-firing guns, and she is fitted with one submerged and two above-water torpedo tubes. Another ship of the same type, letter H, is under construction.

The armament of the auxiliary cruisers "Fürst Bismarck," "Normannia," "Columbia," "Augusta Victoria," "Spree," "Havel," and "Lahn" will consist of eight 6-in. and four 4·7-in. guns, two 3½-in. and two 2½-in. quick-firing guns, and seventeen 1½-in. Hotchkiss guns. These ships have a displacement varying from 8,874 to 5,681 tons and a speed of 19½ knots, except the "Lahn," which is the smallest, and has a speed of 18½ knots. ("Riv. Marittima.")

Holland.—The Minister of Marine has compiled a plan of construction for new ships to be added to the navy, some for the defence of the Kingdom in Europe, and others for the defence of the East Indian Colonies. The first will be composed of six armoured cruisers of 3,400 tons and 16 knots, six "catchers" of 450 tons and 22 knots, eight small vessels of 100 tons and 14 knots; six gun-vessels of 200 tons and 22 knots; thirteen torpedo-boats 130 ft., and four 85 ft. in length. For colonial defence four armoured cruisers of 3,400 tons and 16 knots, one "catcher" and six 130 feet torpedo-boats. ("Riv. Marittima.")

Italy.—The submarine boat "Audace" (sketch in Plate 10).—Experiments with this boat were carried out in December, at Civita Vecchia. She was constructed at Savona from the designs of the engineers Degli Abbati and Sons. Her form is that of a cetacean; the hull is of thick steel plate, and is 28½ ft. long, 7 ft. broad, and 11½ ft. high. In the upper part forward is a small conning tower, and further aft a circular hatch, while at the left-hand side there is a solid door, fitted so that it can be opened when the boat is submerged. The propeller is of cast iron, fitted in a horizontal propeller shaft; there are two rudders, one of the ordinary form, and the other shaped like a fish's tail. All the machinery necessary for manœuvring the boat is worked by electricity, which also serves to illuminate the sea bottom through bullseyes fitted in the sides of the hull. At the trial the boat behaved exceedingly well at a depth of 16 m., but the experiment could not be prolonged, on account of one of the crew having been injured by the machinery, and requiring immediate attention. The inventors say that the boat is strong enough to resist a depth of 100 m., that the air generated by a special apparatus is sufficient for forty-eight hours, and that it is possible to leave the boat and to work at the bottom of the sea without any inconvenience. ("Riv. Marittima.")

United States.—In addition to the "Maine" and "Texas," and the various coast defence turret-ships which are being completed, the United States Government is now building, or has ordered, two armoured cruisers and four sea-going ironclads, which, since they will rank among the most powerful vessels of their classes in the world, merit some attention. Two, the "New York" and "Brooklyn," are armoured cruisers, the remaining four, the "Indiana," "Massachusetts," "Oregon," and the craft provisionally known as "No. 4," are battle-ships of what would in England be denominated the 1st Class. The "New York" is under construction by Messrs. Cramp, at Philadelphia, where also the "Indiana" and "Massachusetts" are being built. The "Oregon" is on the stocks at the Union Ironworks, San Francisco; and the "Brooklyn" and No. 4 have yet to be laid down. The "Indiana," "Massachusetts," and "Oregon" are sister ships; the remaining three vessels are at present of unique types. The general details of the six may be thus tabulated:—

	"New York."	"Brooklyn."	"Indiana," "Massachusetts," "Oregon."	Battle-ship No. 4.
Length in feet	380·5	400	348	360
Beam in feet	64	64	69·2	72
Draught in feet	24	23	27	27
Displacement in tons	8,150	9,150	10,200	11,250
I.H.P.	16,000	16,000	9,000	11,000
Speed in knots	20	20	16·2	16·5
Coal capacity in tons	1,500	1,650	1,800	2,000
Armament.........	6 8-in. B.L.	8 8-in. B.L.	4 12-in. B.L.	4 13-in. B.L.
"	12 4-in. Q.F.	12 5-in. Q.F.	6 4-in. Q.F.	8 8-in. B.L.
"	8 6-pr. Q.F.	12 6-pr. Q.F.	20 6-pr. Q.F.	4 6-in. B.L.
				20 6-pr. Q.F.
"	4 1-pr. Q.F.	4 1-pr. Q.F.	5 1-pr. Q.F.	6 1-pr. Q.F.
"	4 Gatlings	4 Gatlings	2 Gatlings	2 Gatlings
"	4 torp.-tubes	5 torp.-tubes	7 torp.-tubes	7 torp.-tubes
Belt armour, inches..	4	4	18	18
Turret armour, inches	10	5 to 8	17	17
Deck armour, inches	3 to 6	3 to 6	2½ to 3	2½ to 3
Radius of action in miles	13,000	15,000	5,000	6,000
Cost, £	600,000	700,000	800,000	900,000
Weight of metal thrown in lbs.	1,952	2,680	3,725	6,928

It is worthy of note that the weight of metal thrown by battle-ship No. 4 will be about 800 lbs. heavier than that thrown by ships of our own "Royal Sovereign" class. The plans for No. 4 embrace provision for armoured ammunition tubes. This feature was omitted in the other three battle-ships mentioned above, and there has been some question whether the armoured ammunition tube was really a necessity. This tube leads from the magazines to the turrets. If unprotected by armour it offers a vulnerable target to an enemy, and damage to this part of a vessel would seriously cripple her.

Of the above, the "Indiana" was launched with much ceremony at Philadelphia, on the 28th February.

On February 4 a seventh armoured vessel, the harbour defence ram "Katahdin," was launched at Bath (Maine). She was designed by Admiral Ammen, and, beyond a small secondary battery, depends for offensive force upon her ability to ram a foe. She is a turtle-backed craft of very low freeboard, with a displacement of 2,100 tons, and engines of 4,800 I.H.P., which are expected to give her a speed of 17 knots. Her length is 251 ft.; her beam 43 ft. 6 in.; her draught 15 ft., and her deck armour from 2½ to 6 in. thick. She will carry four 6-pr. Q.F. guns. When going into action she can be submerged until only her turtle-back, funnel, and ventilating shafts, all of which are armoured, remain above water. Unlike our own "Polyphemus," which she in many respects resembles, she has no torpedo equipment.

The official trials of the pneumatic guns of the dynamite cruiser "Vesuvius" have begun at Port Royal. The vessel was moored at the naval wharf, and twelve shots were fired the first day, six at a range of 2,000 yds. and six at 1,500 yds., the three guns being fired in succession. With the exception of the first two shots from the starboard gun, no shot fell more than 20 yds. distant from the point aimed at, and all would have struck a ship. No target was used,

but the results were recorded by the observing officer with the aid of theodolites. No difficulty was experienced in the working of the guns or in the supply of air to the reservoirs. The control of the shells by means of wind vanes was also satisfactory. At the next trial, shells, loaded with powder charges, were fired. The experiments were a remarkable success. Five shots were fired while the "Vesuvius" lay close to the buoy marking the 2,000 yds. range, and every shot travelled directly towards the small target. As far as lateral deviation was concerned, all the projectiles would have hit a steam launch. ("Reuter's Telegram.")

The Harvey process for hardening armour plate, according to the "Mittheilungen aus dem Gebiete des Seewesens," is as follows:—The mild, or soft, steel plate is enclosed in a fireproof case or muffle, and is surrounded with pounded wood charcoal, well stamped in; the muffle is then closed, and the whole placed in a heating furnace and brought to an intense heat, about the temperature for melting cast iron; this temperature is maintained constant for a period of time necessary for the absorption of the carbon by the steel plate to the extent previously determined. Originally the plate may contain from 0·1 to 0·35 per cent. of carbon, and an additional 1·0 per cent. may be added by the process; the time necessary for the process depends on the depth to which it is desired to harden the plate. From data given by Mr. Harvey, the time, reckoned from the instant at which the furnace has been brought to the required temperature, is 140 hours for a plate 10½ in. thick, in order to harden it to a depth of 3 in., and to raise the percentage of carbon at the surface to 1·0 per cent., the quantity decreasing gradually to the original percentage at the depth of 3 in. The time necessary to bring the furnace to the required temperature is, as a rule, forty-eight hours. After the plate has been in the furnace the necessary time, it is taken out with the muffle in which it is kept inclosed, and the whole is allowed to cool down gradually till the plate is at a dull cherry-red heat, when it may be cooled by sprinkling water on it, or in some similar way. The proportions of carbon and nickel in three plates supplied for trial, two by Carnegie, Phipps, and Co., Pittsburg, and one by the Bethlehem Iron Company, were as follows:—No. 1. Carbon, 0·45; nickel, 3·06 per cent. No. 2. Carbon, 0·25; nickel, 3·10 per cent. No. 3. Carbon, 0·31; nickel, 3·07 per cent.; the two latter were hardened by the Harvey process above described.

Protection of Iron and Steel Wire against Rusting.—Some experiments recently carried out in the United States to this end were as follows:—The wire is enclosed in a revolving drum, which at first is filled with air, at a temperature of 640° Fah., which is afterwards expelled by the admission of superheated steam; carburetted hydrogen is then allowed to act on the surface of the wire for some considerable time, after which the process is ended by another bath of superheated steam. The metal is then found to have acquired an exceedingly tough surface, which, even under the hammer, it does not readily lose. For the success of the operation it is important that the temperature in the drum should be maintained constant. The cost of the process is only a fourth of the cost of galvanizing. ("Rivista di Artiglieria e Genio.")

We are indebted, among other sources, to the "Times," "Army and Navy Gazette," "Le Yacht," and "Marine Rundschau" for the information contained in the above notes.

MILITARY.

Austria-Hungary.—The French "Revue du Service de l'Intendance Militaire" for November—December, 1892, contains a long article, the first instalment of what promises to be a very complete and instructive essay, on the "Military Administration of Austria-Hungary, its Organization and Working in Peace and War," by Sous-Intendant M. Dupain. A very interesting essay by the same author, on the administration of the Italian army, appeared in the same journal during the year 1892.

According to the "Armeeblatt," as quoted in the "Militär-Wochenblatt," the effective strength of the Austro-Hungarian army is as follows:—

	Peace.		War.	
	Officers and men.	Horses.	Officers and men.	Horses.
Infantry and Jägers—				
103 regiments and 30 battalions	184,180	600	729,670	16,930
54 landwehr regiments	26,960	150	255,370	6,350
Total	211,140	750	985,040	23,280
Cavalry—				
42 regiments	45,360	40,530	71,860	68,840
16 landwehr regiments and other mounted troops	4,420	2,850	15,650	14,980
Total	49,780	43,380	87,510	83,820
Field and mountain artillery—				
50 battery divisions	16,190	7,470	47,430	40,230
11/12 mountain batteries and a battery division	10,930	4,050	33,680	26,750
Total	27,120	11,520	81,110	66,980
Technical troops—				
Pioneers	3,830	40	12,030	1,290
Engineers	4,360	50	11,930	1,130
Railway and telegraph troops	1,120	20	6,600	380
6 fortress artillery regiments and 3 battalions	8,040	70	22,440	100
Total	17,350	170	53,000	2,900
Train and army (reserve) institutions— Total	13,850	1,750	89,710	58,890
Higher commands, &c.— Total	6,400	1,530	19,000	—
Grand total	326,040	57,700	1,315,370	233,570

It will be noted that some of the totals here given are not quite correct. In addition to the war effective above given, there should be shown 430 battalions (each 1,000) and 20 squadrons (150 men) of Landsturm, *i.e.*, 430,000 infantry and 3,000 cavalry.

Bulgaria.—Six cyclist detachments, each consisting of 1 N.C.O. and 8 men, have been formed, one for each division.

France.—It is understood that autumn manœuvres on a large scale for the troops of first line will not be held in 1893, but that it is intended that reserve army corps, with their staffs, &c., complete, shall be exercised during the summer and autumn. It is stated in "La France Militaire," that the reserve regiments will in future be assembled every other year. The reserve regiments to be called out this year will be exercised in garrison duties, in brigades, and in divisions or army corps.

According to "La France Militaire," the expectation that the instruction of recruits in reading and writing would in future be unnecessary, owing to compulsory education in the civil schools, has not yet been realized. In consequence of the reports of Commanding Officers, that the number of illiterate men was steadily diminishing, and was already so small that it was not worth while continuing to give elementary instruction in regimental schools, such instruction was discontinued under an Order of July 17 last. The number of illiterates, however, who joined certain regiments with the last batch of recruits was so considerable, that it is deemed advisable to continue to supplement the civil education in army schools, and the War Minister has called upon the Commanders of the artillery and train to report on the number of uneducated men in the last category of recruits.

With the object of inducing more volunteers to join the Marine troops, it has been notified that youths between 18 and 20 years of age who may volunteer for four or five years' service, if in all respects sound and strong, may be accepted even if their chest measurements do not come up to the prescribed minimum of 78 cm. (say, 30¾ inches). ("Le Progrès Militaire.")

The establishment of regimental workshops, in which it is proposed to make the clothing for the army, has, according to "Le Progrès Militaire," caused a considerable amount of feeling among the contractors who have hitherto had the supply in their hands, and they have brought their grievances to the notice of the War Minister. The latter is reported to have informed the delegates of the contractors that the new system of supply is only on trial, and that every possible consideration would be shown to their interests. The paper quoted from hails the innovation as a most welcome one, and expresses the hope that the administration of the army will proceed still further in the path of decentralization. The civil workmen would not be deprived of employment, as the regimental master tailors, &c., would not be able to dispense with their assistance; on the other hand, the troops would no longer run the risks to which they are now exposed owing to strikes, &c., and, moreover, the soldier would be better clothed and shod, if his immediate superiors were responsible, than he would be if the supplies were drawn from contractors.

In addition to the Périer biscuit, mentioned last month, a new "tablette de pain" has also been issued to the troops for trial. This iron-ration bread has been favourably reported on by the Technical Intendance Committee, and, like the Périer biscuit, is intended to be used in making the soup. ("Bull. Officiel.")

"L'Avenir Militaire," No. 1755, gives an interesting statement of the dates of previous commissions of officers of the several arms and ranks who may expect promotion to the next higher rank. The infantry officers are the worst off, and then come the engineers, cavalry, and artillery, in that order.

Experiments are being made with a mountain machine-gun, for mountain troops and independent cavalry divisions. It is said that the entire gun and 2,000 rounds are carried by a single horse, and 600 rounds can be fired in one minute. ("L'Avenir Militaire.")

It is stated in the "Revue du Cercle Militaire" (No. 7), that orders have been given for the manufacture of 700 "bicyclettes," of the pattern approved in a Ministerial decision of January 10. The weight of the regulation model is 18 kilos.

(39 lbs. 11 oz.). The journal quoted maintains that the solution of the problem of mounted infantry will some day be given by the cyclists, and gives some account of their performances at the manœuvres of 1892.

Germany.—An interesting experiment was carried out in January of this year by a portion of the 1st Bavarian Field Artillery Regiment. The scene of operations was the country between Munich and Freising, in Upper Bavaria. Intense cold prevailed at the time, the ground being frozen quite hard and covered with snow. The object of the experiment was, firstly, to ascertain the effect of such conditions upon ranging and laying; and, secondly, to ascertain the effect of shell fire under such circumstances. Infantry, cavalry, and artillery were all represented by suitable targets, and the position which they occupied was first carefully reconnoitred. Two batteries, of six guns each, made up to war strength, then came into position and opened fire with ring, shrapnel, and high-explosive shells, 500 rounds being fired in all. Details of the practice are not to hand, but it is stated that the results were highly satisfactory. (" Allgemeine Militär Zeitung.")

The following figures, taken from the " Mil.-Wochenblatt," form a contrast to the statistics given below regarding the state of education of the Russian recruits. Soon after joining the colours, the German recruit is examined, in order to ascertain whether he can read German or any other language, and can write his Christian and surname in a legible manner. Those who do not pass this test are classed as "illiterate." A comparison of the percentage of recruits of this class in the categories of 1881-82 and 1891-92 shows the great progress that has been made in civil school instruction:—

Illiterates in..	1881-82.	1891-92.
In Prussia..........	2·34 per cent.	0·69 per cent.
„ Bavaria	0·17 „	0·01 „
„ Saxony........	0·23 „	0·01 „
„ Württemberg....	0·02 „	—
„ Elsass-Lothringen	1·26 „	0·35 „

During the last ten years the number of illiterates for the whole of Germany diminished from 1·54 to 0·45 per cent.

In the winter of 1891-92, experiments with snow shoes were carried out, by order of the War Ministry, in three battalions. The shoes were supplied by the "Tourist," the organ of the Tourist Association. Further trials have been made this winter in other regiments also, and the results show that these snow shoes might be of great use in case of a winter campaign, as with them the deepest snow can be crossed with ease. (" Mil.-Wochenblatt.")

The general details for the great manœuvres of 1893 are published in the "Militär-Wochenblatt," No. 16. The army corps to take part in the Emperor's manœuvres are the VIIIth, XIVth, and XVIth.

The following is the substance of a notice of the new military law before the Committee of the Reichstag which appears in the " Revue Mil. de l'Étranger." The point on which the discussion turns is the determination of the conditions which shall regulate the service of two years. According to Article I of the "projet," the peace effective is fixed at an average of 492,068 men, excluding non-commissioned officers, on the basis that the foot troops will, as a rule, serve with the colours for two years. In this form the article has given rise to numerous objections. The Committee, as a whole, consider that it does not sufficiently define the position of the men during the third year, and the representatives of the Centre, the National Liberals, the Liberals, and the Socialists demand a positive guarantee that the men shall be released from service with the colours and passed into the Reserve as soon as they have completed two years' service. Three separate amendments have been proposed. Herr Rickert proposes 7 years of active service for every German, viz., from his completed 20th to his 28th year; foot soldiers to serve

2 years with the colours and 5 in the Reserve, men of the other arms to serve 3 years with the colours and 4 in the Reserve. Herr Bebel does not approve of any distinction being made between the period of service of the foot and mounted men. Herr von Bennigsen proposes that foot soldiers shall serve with the colours for 2 years, and then pass into the Reserve for the following 5 years; this arrangement to be in force only so long as the peace effective does not fall below the figures fixed by Article 1.

All these three amendments really express the same idea, viz., that at the end of their second year of service the men shall return to their civil life as Reservists, and so shall be released from the obligation to hold themselves at the disposal of the military authorities. This refers to men on leave at disposal ("Dispositions Urlauber"), who, under the existing law, are sent to their homes at the end of their second year of service, but are still counted as belonging to the active army, can be recalled to the colours during the third year when required to do so by army corps Commanders, and are forbidden to emigrate.

On the other hand, Herr von Hammerstein, speaking in the name of the Conservatives, maintains that the three years' service with the colours should be continued as a principle, the military authorities retaining the faculty of releasing the men on leave during the third year; and this view is warmly supported by General von Gossler, the representative of the War Minister, on the ground that it is indispensable to have constantly in the country a third class, of perfectly instructed men, in addition to the two classes with the colours.

Italy.—Recent regulations give greater facilities to officers of the army who may wish to change garrisons or corps on account of personal or family reasons. An officer, besides adducing satisfactory reasons for wishing for the change, must be classed as "very good" or "good," and must have served two years in his present garrison or corps. If a corps changes garrison, or is about to do so, the privilege referred to is only to be granted in exceptional circumstances, and, as a rule, will not be accorded until the expiration of six months after the change of garrison. Further privileges have also been granted in the matter of ordinary leave; among others the permission to enjoy leave in the garrison town where an officer's corps is stationed, with freedom to wear civil clothes during such leave. ("L'Italia Militare.")

In accordance with the law of 28th June, 1891, the number of yearly classes of men liable to military service is 21 instead of 19, and includes all men fit for service from the age of 21 to the completion of their 41st year. The grand total of 3,215,000 given in the "Revue Mil. de l'Étranger" for February, is thus arrived at:—

	1st Category, completely instructed.	2nd Category, partly instructed.	3rd Category, not instructed.
	men	men	men
Permanent army (3 classes with the colours, 6 on leave)	670,000	127,000	—
Mobile Militia (6 classes on leave)	312,000	207,000	—
Territorial Militia (6 classes on leave)	328,000	225,000	1,346,000
	1,310,000	559,000	1,346,000
Grand total	3,215,000		

Roumania.—The Roumanian Government has not yet decided upon the small-calibre rifle to be adopted for the infantry, but it appears that competent judges are in favour of the Mannlicher rifle (6·5-mm., Model 1892). 8,000 arms of this pattern are now in use, and searching trials are being conducted with the view of determining the advantages and disadvantages of the weapon. ("Spectateur Militaire.")

Russia.—According to the "Voyenni-Sbornik," the ages and length of service of the officers of one of the infantry divisions on January 1, 1892, were as given below. The ages of the majority ranged between 27 and 38 years:—

Rank.	Age.	Average.	Length of service.	Average.
Colonels	45—54 years	50 years	28—35 years	32 years
Lieutenant-Colonels	40—55 "	45 "	15—37 "	28 "
Captains	34—55 "	42 "	18—36 "	24 "
Staff Captains	30—50 "	38 "	11—28 "	20 "
Lieutenants	23—41 "	30 "	6—24 "	12 "
Sub-Lieutenants	19—30 "	25 "	2—12 "	5 "

At a lecture read before the Imperial Technical Society on December 5, Colonel Adasovski expressed his opinion, with reference to the experiments conducted at Krassnoe Selo in 1892, that a captive balloon which was within range of the shrapnel fire of a battery of eight guns, if fired at according to the method proposed by him, would not live, and would be rendered useless in three or four minutes. ("Mil.-Wochenblatt.")

Details of recruiting operations in Russia in 1891 are given in the "Mil.-Wochenblatt," No. 9, from which the following figures are taken:—

	Europe and Siberia.	Caucasus.
Total number liable to service having completed their 20th year	968,122	26,136
Actually incorporated in the army or navy	258,865	2,399
Put back for insufficient development, sickness, &c.	100,773	1,269
Did not present themselves	29,868	2,555
Absolutely exempted, owing to unfitness	49,899	1,022
Of the men incorporated, those who were more or less educated numbered	18,658	3
Ditto, could read and write or only read	67,408	447
Ditto, were totally ignorant	172,671 (66·70 p. c.)	1,949 (81·25 p. c.)

The nationalities of the men incorporated were as follows:—

	Europe and Siberia.	Caucasus.
Russians of all races	191,694	—
Poles (Armenians in the Caucasus)	17,770	1,082
Tartars (or Greeks)	5,005	2
Lettonians of various races	7,818	—
Jews	16,500	34
Germans (others in the Caucasus)	3,878	939
Finns and others	16,000	342

The beginning of reserve formations has been made in Transcaspia, two reserve battalions having been authorized (at Kushk and Geok-Tepe) in November last.

With the view of opening up new markets for Russian horse-breeders, a consignment of specimens of the chief Russian breeds will be sent for exhibition at Chicago. It is hoped that the Orlov trotter will beat the Canadian trotter out of the field, and take possession of the American market. Similarly, it is expected that a market will be found for the heavy Russian cart-horse, for the small and enduring so-called "Swede," and for the saddle-horses of pure English and Arabian blood, reared in the Imperial studs. The Don and Steppe breeds will also be represented. ("Mil.-Wochenblatt.")

Extensive experiments have been made for some time past with electric illumination from balloons. The apparatus employed has an illuminating power of 5,000 candles. In misty weather a surface of about 500 m. diameter was well lighted from a height of 600 m. From a height of 150 m. the cone of light was so directed as to thoroughly illumine 1 km. of road. The illuminators are said to be very easy to regulate and apply in the required direction. They are to be extensively employed at the next siege manœuvres before Ivangorod. ("Zeitschrift für Luftschiffahrt," 12 of 1892.)

Spain.—The "Memorial de Artilleria" for November last gives a description of an infantry target with automatic electric register. The apparatus is the invention of E. Ordiales, foreman of the firing ranges at Carabanchel, and its object is to ensure self-registration of hits, and so avoid the possibility of error. A short description is also given in the Austrian "Mittheilungen über Gegenstände des Artillerie- und Genie-Wesens," 1893 (2nd Heft.).

The following short account of the forthcoming reforms in the Spanish army has been taken from the Spanish newspapers "El Imparcial" and "El Faro de Vigo," but can only be looked upon as approximately correct:—

Military Schools.—From the 1st July next the schools of instruction for officers of the army will be—

The academy for infantry at Toledo.
" " engineers at Guadelajara.
" " artillery at Saragossa.
" " cavalry at Valladolid.
" " military administration at Avila.

The "Academia General" will be abolished, but a "Superior War School" will be formed in Madrid.

The course of instruction in the infantry and cavalry schools will last three years, at the end of which time, provided the cadets have passed the required tests, they will be promoted to Second Lieutenants.

In the engineer and artillery schools the course of studies will be for five years,

and at the end of the third year those students who pass the required tests will be promoted to Second Lieutenants, and at the end of five years to First Lieutenants.

The Superior War School will open on the 1st September, 1893, and is intended to spread among the officers of the army the highest forms of military knowledge, and also to prepare officers for the General Staff of the army. The entrance to this school will be by competition, and the vacancies which occur will be announced annually. First Lieutenants of all arms will be eligible to compete.

The Director will be a General of Division or of Brigade, the second in command a Colonel, the Professors Lieutenant-Colonels and Majors.

Artillery.—The artillery will consist of 16 regiments, viz., 14 mounted and 2 mountain, and 10 fortress battalions.

Each regiment will have 2 batteries instead of 4, as at present, with the effective on a peace footing; but the sections will have an increased number of ammunition wagons, and the personnel necessary for this increase in wagons. The batteries undergoing the above-mentioned reductions will retain their cadres of officers and men, but without having any fixed strength; the surplus guns will be distributed among the 14 mounted and 2 mountain regiments, a portion being also assigned to the fortress battalions.

Engineers.—The engineers will be composed of 4 regiments of sappers and miners, 1 pontoon regiment, 1 telegraph battalion, and 1 railway battalion. The pontoon regiment, and the survey, telegraph, and railway companies will be reduced in strength, but will retain their cadres intact, in order that command and instruction may alternate.

Infantry.—The regiments of infantry will consist of 2 battalions. One battalion of 4 companies will have the effective on a peace footing; the other battalion will remain intact, not being reduced in either officers or battalion staff.

Cavalry.—The alterations in this arm are not yet quite decided on, but it is believed that in each regiment one of the squadrons will be converted into a depôt squadron, the other three being increased.

The Recruiting Zones.—The 111 recruiting zones will be reduced to 65, thus increasing the zones territorially, and the number who are liable to serve in each zone. Further, cadres of reserve regiments will be created.

FOREIGN PERIODICALS.

MILITARY.

Militär-Wochenblatt.—No. 9. "Opinions regarding the Infantry Attack." No. 10. "Criticism of General von Scherff's 'Praktische Taktik und Taktische Theorie.'" "The effect of the proposed (German) Military Law, from a Company Chief's point of view." "General Brialmont and the Turkish works of Defence." No. 11. "Criticism of von Scherff's book" (*continued*). "Experimental firing at the Krupp Works with the 6-cm. Q.F. Field-guns" (in some detail). No. 12. "Review of Mackensen's 'Schwarze Husaren.'" "Experimental firing at the Krupp Works" (*concluded*). "Review of Graf Starhemberg's account (in the 'Neue Freie Presse') of his distance ride on 'Athos' from Vienna to Berlin." No. 13. "Review of Boguslawski's 'Die Landwehr von 1813 bis 1893.'" "School Education of German Recruits." "Electric Transmission without Conductors." "Reorganization of the School of Saint Cyr." No. 14. "The Ersatz Reserve." "Army Reorganization and Military Activity in Switzerland." "The new Law of Recruitment in Italy." "Historical Sketch of the Russian Military Academies." No. 15. "An Examination of the Report on the French Military Budget for 1893." "Army Reorganization, &c., in Switzerland" (*continued*). "Peace and War

Strength of the Austro-Hungarian Army." No. 16. "Examination of the French Budget" (*continued*). "The present Organization, Distribution, and Strength of the French Infantry." "The Cooking of Food in War" (a criticism of Major Hahn's book). "School of Cookery for the English Army."

Neue Militärische Blätter.—January. "The First Fights of the Army of the Rhine in 1870, according to the Personal Narrative of a French Officer" (*continued*). "Art in War." "History of the Prussian Reserve Corps, from Magdeburg to the Capitulation of Prenzlau." "On Sea Mines." "Russia's Warlike Constructions (Sea and Land) in the Black Sea." "The French Reserve Divisions in the Autumn Manœuvres of 1892."

Jahrbücher für die Deutsche Armee und Marine.—February, 1893. "Autumn Manœuvres of the 9th and 12th Army Corps in 1892" (*concluded*). "Tactical Comments on the Manœuvres in the Warsaw District." "Armament, Equipment, and Training of the (German) Cavalry in the last decennium of the 19th Century." "Armoured Works, from an economical point of view, as instanced in the case of Liège and Namur," by Lieutenant-Colonel R. WAGNER (*concluded*). "Egypt and the Red Sea, their Strategical Importance," by OTTO WACHS. "The new Organization of the Swedish Army."

Organ der Mil.-Wiss. Vereine.—Heft 1. "About the employment of Field Artillery." "Examination of the new (Austrian) 'Trainvorschrift für die Armee im Felde' and 'Vorschrift für den Militär-transport auf Eisenbahnen.'"

Revue Militaire de l'Étranger.—February. "The Latest Trials with Armour-plates in the United States." "The New Bulgarian Military Law." "The Railway System of Norway."

Journal des Sciences Militaires.—January. "Strategy of Marches" (*continued*). "Cryptography" (*continued*). "Education of the Soldier" (*continued*). "Study on Cavalry," by a superior officer of infantry (*continued*). "The Campaign of 1814" (*continued*). "Military Topography of Upper Alsace" (*continued*). "Kollin—Austerlitz—Saint-Privat—Leuthen; a Comparative Study" (*concluded*). February. Continuation of articles on "Strategy of Marches," "Cryptography," "Education of the Soldier," "Campaign of 1814." New articles on "The War in Chili," "Military Balloons," "Tactical Instruction of Officers," "Collective Fire of Infantry," "Rifles of Small Calibre; a Comparative Study." "The Fight at Châtillon and Investment of Paris by the Vth Prussian and IInd Bavarian Corps" (*concluded*).

Spectateur Militaire.—1st February. "Regional Recruiting" (in France). "Operations of Junot and Wellesley before Lisbon" (*continued*). "Tactics of the Wars of the Middle Ages" (*continued*). "Studies on the Campaign of the Loire" (*continued*). 15th February. "The German Army, from the moral point of view." "Operations of Junot and Wellesley before Lisbon" (*continued*). "Tactics of the Wars of the Middle Ages" (*continued*). "Studies on the Campaign of the Loire" (*continued*). "The French Guards and the Swiss Guards."

Revue du Cercle Militaire.—Nos. 7 and 8, of February, contain an account of the history and present condition of the Military Society (Militärische Gesellschaft) of Berlin, which celebrated its fiftieth anniversary on the 24th January. These numbers also give an account of an interesting lecture by Dr. Lallemont (begun in No. 5) on field hospitals, which gives a clear idea of the medical field arrangements in the French army.

Revue de Cavallerie.—January, 1893. "The Supply of Men and the Remounts of the Cavalry of the Grand Army in 1806–7" (*continued*). "The Cavalry at the Manœuvres of the 9th and 12th Corps in 1892." "The Double Armament of Lancers under the First Empire."

Revue du Génie Militaire.—September—October, 1892. "Military Works at El-Oued in the Sahara" (routes; construction of the redoubt; building materials available; formation of wells, &c.). "Description of the new Civil and Military Hospital at Montpellier, with accommodation for 610 patients." "Use of Inflated Skins for Passage of Streams." "Type of Redoubt used in the Dutch East Indies against Uncivilized Tribes." "Military Baths." "Transport over Snow."

Revue Militaire Suisse.—February, 1893. Contains the first instalment of an article describing in detail the organization, armament, and employment of the Swiss Landsturm.

Journal of U.S. Cavalry Association.—December, 1892. "Cavalry upon the Field of Battle," from the Russian of Lieutenant-Colonel Prejentsoff (*continued*). "The Saber" (consideration of the possibility of the mounted action of cavalry under modern conditions of warfare). "Conversations on Cavalry" (from the German of Prince Kraft zu Hohenlohe-Ingelfingen) (*continued*). Paper on "The Trot as a Cavalry Gait," and discussion thereon. "The U.S. Cavalry Remount."

NOTICES OF BOOKS.

Almanach für die k. u. k. Kriegs-Marine, 1893. Published with the permission of the Marine Section of the Imperial Ministry for War, by the Hydrographical Department at the Imperial Dockyard at Pola, and under the supervision of the Editor of the "Mittheilungen aus dem Gebiete des Seewesens." 12th year of the new edition. Pola and Vienna: Gerold. 4 mks.

This little work is undoubtedly, for all naval officers possessing a knowledge of German, the most valuable manual published in any country on naval matters. It is simply crammed full of interesting information, and it is astonishing that so much useful matter can be compressed into so small a compass as is to be found in the work before us. It contains a list of the war-ships of every country, including torpedo-boats, school, gunnery, and training ships, troop-ships, yachts, and even tugs and vessels for dockyard service, as well as all merchant steamers retained as auxiliary cruisers; there are no less than 144 wood-cuts, side and deck sketches of the principal armour-clads and armoured cruisers of different nations, showing the disposition and thickness of armour and the position and arcs of training of every gun. In the lists of ships are also given their full dimensions, horse power, speed in knots, coal stowage, thickness and disposition of armour, with description of guns, calibre, whether Armstrong, Krupp, Canet, &c., and date of launch. It also contains a full description of all the guns in use in different countries, with their dimensions, the system and where constructed, ballistic data, nature of powders employed, the different projectiles, initial velocities, &c., and the different mountings. Among the other contents of the work may be mentioned a table of weights and measures used in all countries, with the metric system reduced to English weights and measures, the equivalent of metre-tons being even given in English foot-tons, and *vice versâ*, for convenience in calculating the striking energies of different projectiles mentioned in the gunnery part of the work. The latter part of the almanack gives the pay in all branches of the Austrian navy, and different regulations relating to leave, pensions, and entry of officers, concluding with a list of all the officers on the active and reserve lists in the Imperial fleet. There are 389 pages in the work, which is of so convenient a size that it can be comfortably carried in a breast-pocket; at the same time, the print is clear and of a perfectly readable type. It is much to be wished that some such book of reference, of so convenient a size, could be published in England for the use of naval officers, as the work in question undoubtedly contains information which is not obtainable by English officers except at the cost of considerable time and trouble.

List of Recent Foreign Books (Military).

Stratégie et Grande Tactique d'après l'Expérience des dernières Guerres. Par le Général Pierron.

Tome 1. Lines of communication; their necessity, protection, and organization. Pp. 656. With plates. 1887. 10 fr.

Tome 2. Navigable ways and reconnaissance of rivers, &c.; railways; construction, repair, and destruction of works; telegraphic, postal, and sanitary services (hospitals, ambulances, evacuation of sick and wounded); horse depôts and infirmaries; magazines on line of communications; hutting. Pp. 826. With plates. 1890. 15 fr.

Tome 3. Replenishing provisions and *rôle* of the intendance; replenishing ammunition and service of artillery in rear; service of engineers in rear; requisitions; police in rear. Pp. 640. With plates. 1892. 10 fr. Paris: Berger-Levrault.

Aperçus sur la Tactique de Demain, mise en rapport avec la Puissance du Nouvel Armement et l'Emploi de la Poudre sans Fumée. Par le Commandant Coumès. Paris: Baudoin, 1892. 9 fr.

La Frontière, 1870—1882—1892. By Eugène Ténot. 2nd Edition. With General Map of the Defences of France, Map of the Defences on the East, &c. Paris: Rouam, 1893. 9 fr.

L'Armée et la Flotte de 1891 *à* 1892. *Les Grandes Manœuvres Navales et Militaires de* 1892. By M. Ardouin-Dumazet, Rédacteur militaire et maritime du "Temps." Paris: Rouam. 3 fr. 50 c.

Réglage et Organisation du Tir des Batteries de la Côte. Par A. Rivals, Capitaine d'Artillerie. Paris: Berger-Levrault, 1892.

Traité de Topographie et de Reconnaissances Militaires. By Lieutenant-Colonel E. Bertrand. 4th Edition, with 279 figures. Paris: Baudoin, 1893. 8 fr.

L'Armée Austro-Hongroise, d'après les documents officiels et des notes personnelles. By General Baron Kaulbars. Authorized translation from the Russian. Paris: Westhausser, 1893. 4 fr.

Der Krieg von 1806 *und* 1807. By Colonel von Lettow-Vorbeck. Vol. 1, Jena and Auerstedt. With plans. 10 mks. Vol. 2, Prenzlau and Lübeck. With plans. 11 mks. Berlin: Mittler.

Geschichte des Festungskrieges seit allgemeiner Einführung der Feuerwaffen bis zum Jahre 1892. By Lieutenant-General H. Müller, Director of the Arms Department. Berlin: Mittler. 9 mks.

Kriegsgeschichtliche Beispiele der Feldbefestigung und des Festungskrieges. By Major Krebs. 2nd Edition. With plates. Berlin: Mittler, 1892.

Der Kleine Krieg und der Etappendienst. Kriegsgeschichtliche und taktische Studie. Von G. Cardinal von Widdern. With sketches. Leipsig: A. Reisewitz, 1892. Part I, 3 mks.; Part 2, 1.50 mks.

Scharfe Taktik und Revue Taktik im 18. *und* 19. *Jahrhundert. Zehn geschichtlich-taktische Abhandlungen.* By Lieutenant-Colonel D. von Malachowski. With sketches. Berlin: Mittler, 1892. 6 mks.

Das "Kleinste Gewehrkaliber." By Major-General R. Wille. Berlin: Eisenschmidt, 1893. 2 mks.

Eine Neue Indirecte Richt-Methode für die Feld-Artillerie. By H. E. von Brilli. Verlags-Anstalt "Reichswehr," Vienna, 1893. 1 fl.

Der Kriegshund und seine Dressur. By J. BUNGARTZ. Leipsig: Twietmeyer, 1892. 2.50 mks.

Dislokations-Karte der Französischen Kriegsmacht. Scale, 1/1,200,000. With text showing the organization, distribution, and strength of the French army and navy. By Major VON TRÖLTSCH. 5th Edition. Berlin: Mittler. 5 mks.

Militär-Strafgesetzbuch für das Deutsche Reich. (Text and annotations.) By W. L. SOLMS. 3rd Edition. Berlin: Guttentag, 1893. 2.50 mks.

Die Landwehr, 1813—1893. By BOGUSLAWSKI. Berlin: Mittler, 1893. 60 pfg.

Die Zubereitung der Speisen im Kriege. By Major HAHN. Berlin: Mittler, 1892. 1.20 mks.

Billige und gesunde Ernährung. By Captain WANICK. Vienna: Braumüller. (Price ?).

Die Mathematik in der Pferdedressur. By O. VON MONTETON. Dresden: Friese. 1.50 mks.

300 *Tage im Sattel. Erlebnisse eines Sächsischen Artilleristen im Feldzuge* 1870–71. By F. B. WAGNER. Dresden: A. Köhler, 1892. 2 mks.

The *Militär-Literatur-Zeitung,* No. 3 of 1893 (issued with the *Militär-Wochenblatt,* No. 16), contains an account of the Russian periodical military literature during the year 1892.

Storia dell' Arte militare antica e moderna. By Capitano VITTORIO ROSSETTO. Milan: Ulrico Hoepli, 1893.

(NAVAL.)

Notes on the Year's Naval Progress. Annual of the Office of Naval Intelligence, Washington, 1892.

Trattato di Navigazione. Di PASQUALE LEONARDI CATTOLICA, Capitano di Corvetta; Libro di testo per la R. Academia Navale. Livorno: Tip. de Raffaello Giusti, 1893.

Annuario Astro-Meteorologico con Effemeridi Nautiche per l'Anno 1893. Venezia: Tipografia editrice di M.S. fra compositori tipografi, 1892.

Nozioni di Elettricità e di Magnetismo. By GIULIO BERTOLINI. Genoa: Tipografia del Regio Istituto Sordo-Muti, 1892.

Note sul Calcolo dello spessore delle Caldare a Vapore. By FRANCESCO SINIGAGLIA. Naples: Stabilimento tipografico del Cav. A. Morano, 1892.

CORRECTI

The following correction should be mad
(No. 181), page 229. In Captain Scott-M
Employment of Engineer Field Compani
3rd paragraph should read:—"A British
fighting troops:—2 brigades of infantry (ea
cavalry, 3 batteries of field artillery, with d
1 field company of engineers."

)RRECTION.

ould be made in the Journal for March, 1893
.in Scott-Moncrieff's paper on "The Tactical
l Companies, &c.," the 1st sentence of the
A British division consists of the following
infantry (each of 4 battalions), 1 squadron of
lery, with divisional ammunition column, and